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EFFECT OF BLACKFLY LARVICIDING IN SOME ADIRONDACK STREAMS[1]

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ABSTRACT

The effect, on other stream arthropods, of aerial spraying with DDT and methoxychlor for blackfly control was studied on several Adirondack streams, primarily in the Schroon River watershed. Samples from the stream bottom were taken before and at intervals after treatment, and live individuals of the orders Plecoptera, Ephemeroptera, Trichoptera and Diptera were recorded and preserved. Similar data were taken for comparable untreated streams. Weight of the organisms collected was used as the basis of comparison. Weights varied widely, but there was an apparently direct relationship between the population by weight in early May (at the time the first post-treatment samples were taken) and that at later intervals during the season. Therefore, a procedure was devised for calculating, for a given stream in a given year, values for the later samples as percentages of the first sample which was considered to be 100. These percentages for the different streams could then be compared. The data showed that both DDT (as a 20 per cent solution) and methoxychlor (as a 15 per cent solution) had a significant effect on arthropods other than blackflies in the streams studied. Percentage overlap and Margalef's diversity index as means of assessing population are also discussed.

Travis (1949) reported that DDT in fuel oil, with an additional solvent, caused complete detachment of blackfly (*Simulium* sp.) larvae for a distance of one-half mile downstream when applied at 0.1 pound per acre in a 100-foot swath across a stream. This dosage approximates 0.1121 kilograms per hectare in a swath about 30.5 meters wide, accord-

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ing to the conversion of Fisher and Yates (1957). The first larvicidal applications in New York were reported by Travis et al. (1951).

Jamnback and Collins (1955) reported applications by fixed-wing aircraft and recommended dosages of 0.1 pound per swath-acre on ¼-mile centers, crossing streams at right angles. DDT in 20 per cent solution was recommended. The original solutions contained technical DDT plus equal parts of fuel oil and Sovacide F, an effective DDT solvent. Emulsions were not recommended. They concluded that airplane spraying at the recommended rate did not significantly alter the species composition or numbers of arthropods other than blackflies in the treated streams. These conclusions were based on the collection of drift following treatment in addition to square-foot samples taken above and below the points of treatment.

In 1959, it was learned through newspaper publicity that a blackfly spray program was being conducted for the first time in the Schroon Lake area. This information was obtained too late for any studies previous to spraying. The spray operations differed from those reported by Jamnback and Collins (1955) in that the DDT mixture was composed of DDT, fuel oil and a small amount of Triton X100 to effect greater distribution of the DDT and increase the efficiency of the treatment. Observations following spraying indicated an apparent change in the abundance of riffle-inhabiting arthropods, other than blackflies, in the sprayed areas compared with that in unsprayed areas. Random sampling in 1960 appeared to confirm these conclusions. Accordingly, arrangements were made to begin a study of the effect of the spraying in 1961.

The work was carried on over the period from 1961 to 1971, primarily on a part of the Schroon River watershed in the general vicinity of Schroon Lake in Essex and Warren Counties. The streams used were The Branch, Niagara Brook and the Schroon River above the Lake, Paragon Brook between Eagle Lake and Paradox Lake, and Trout Brook which joins the Schroon River below the Lake, plus East Stony Brook, a tributary of the Sacandaga River in the Town of Hope in Hamilton County.

DDT was used as the larvicidal agent in 1961, 1962 and 1963, but its use was then discontinued in the Schroon Lake area because of its harmful effect on lake trout. In 1964 and 1965, no legal larviciding was done. After that, some use was made of methoxychlor. Spraying was done from a fixed-wing aircraft, the speed of which and the rate of spray discharge were calibrated to deliver 1 gallon of 20 per cent DDT, or 1 gallon of 15 per cent methoxychlor, per flight mile. Applications were made two or three times within a period of a little less than 2 months in the spring. They were made during the early-morning or late-evening hours when air conditions are most suitable. Streams were crossed at right angles, and swaths were spaced on approximately ¼-mile centers.

The small amount of chemical affecting the stream populations is indicated by the following comparisons. A discharge of 1 gallon of 20 per cent DDT per flight mile is equivalent to 0.1233 kilogram per hectare. It has been calculated that 25 per cent or less of the quantity discharged at normal elevations above tree level reaches ground zero. Thus, each linear foot of a 120-foot swath would receive $\frac{0.000303}{4}$ or 7.6×10^{-5} pounds of DDT, and each square foot of swath would receive not more than $\frac{0.000076}{120}$ or 6.4×10^{-7} pounds. Assuming an average water depth of 1 foot in this area, the concentration if thoroughly mixed within the area would not exceed $\frac{0.00000064}{62.5}$ or 1.02×10^{-8} pounds per pound of water. This is equivalent to about 10.2 parts per billion. The hydrophobic character of DDT causes it to be rapidly lost from solution, and it is doubtful if this concentration could be attained or persist even in this area. Further reduction occurs in passage downstream to the next swath about ¼ mile below, both by loss from solution and by dilution. Over much of the area the concentration would be far less. Since methoxychlor was used at ¾ the rate of DDT, concentrations in the stream would be proportionately lower.

Only aircraft application is authorized by this State because hand application appears to result in excessive dosages and stream damage. The efficiency of aircraft application probably is due to the almost instantaneous deposition of the chemical over 100 to 120 feet of stream, avoiding "hot spots" and providing enough exposure time to affect larvae even in the swath area. Though further reduced by mixing downstream, the exposure time is increased allowing it to still be effective.

PROCEDURES

Since the larviciding treatment used was known to be effective on blackflies, the plan was to assess its effect on the abundance of other arthropods in the streams studied. Many factors can vary the effectiveness of aircraft applications of pesticides; for example, temperature, slight variations in the height of the aircraft, rate of flow and turbulence of the stream, and impoundments in its course. In any circumstance, not all of the released spray reaches ground level. Early-season sampling can be made difficult, if not impossible, by high stream flow. Downstream sampling areas may have populations reduced by anchor ice, ice gouging and high stream velocities. Early-season drift in the infertile stream of the Adirondacks is low, except during and following chemical treatment. Populations vary in the same stream from year to year.

The studies of Jamnback and Collins (1955) involved evaluation based on determining the numbers of arthropods only, and similar studies

have usually followed the same procedure. However, it has been observed that large numbers of small, newly-hatched larvae may appear and persist for some time during periods of reduced predation. Such a condition would on numbers, indicate an increase in productivity even though the total weight of food per unit of area, for fish in the stream, was greatly reduced. Therefore, weight per unit of area was considered a better and more significant measurement of productivity.

Also, blackfly-control treatments must involve the whole course of an individual stream if they are to be effective. In this type of treatment, there are no untreated upstream areas to serve as a control during the same season. This raised other problems in evaluation as discussed in more detail under a later topic. However, during the period methoxychlor was used, coverage of the area was not the same as it had been for DDT. This permitted comparative studies to be made in a number of the same streams, some with no treatment and some with methoxychlor treatment. Use of the same streams and sampling stations gave more consistent comparisons than could be assured if out-of-area streams had been used for all control studies.

Sampling

Stations were chosen in accessible portions of the stream in locations where an appreciable rise or fall in stream levels would not alter the size of the submerged area. This avoided mathematical correction for variation in size of the habitable area, as described by Burdick et al. (1960). They were required to have, as nearly as could be determined, a uniform consistency in the size and distribution of rubble and gravel in the central part of the flow, as well as an area that would permit the collection of nine sets of two square-foot samples during the season without resampling any previously disturbed portion.

Samples were taken only in the central portion of the riffle. Even though this would tend to reduce the diversity which might be evident in sampling from bank to bank, the lesser variation occurring in the center of the stream would justify the use of fewer samples which would still show the effect of treatment if significant. The effect of seasonal and other variations that could occur would have to be determined by repeated yearly studies and mathematical treatment.

Southwood (1966) reviewed the work of various authors and drew a number of conclusions on the efficiency of sampling in streams but did not specify the conditions under which the comparisons were made. Practically all samplers have advantages in certain situations. Whether or not the use of removable boxes is the most accurate method of sampling bottom fauna is questionable, since if the box is filled with the stream substrate it may not correspond at all to the natural stream bottom, and it would be practically unusable if dependent on self-filling in the rocky,

coarse-gravel or rubble bottom of many Adirondack streams. Stream velocities may be high and silt is infrequent, as is fine sand except in low-velocity-flow areas. In such a situation there is no disadvantage in using the Surber sampler where flows are adequate to carry the arthropods from the sampled area into the net. Southwood did indicate that this sampler gives fairly good proportionate samples, and choosing areas of nearly uniform consistency can improve the accuracy of the proportions.

Jamnback and Collins (1955) described a study involving 21 collections of four samples each from homogeneous areas of stream bottom (Adirondack streams). They reported that a single sample taken from such an area with a population of less than 50 arthropods per square foot had a 95 per cent probability of being within 5.6 of the true mean for the homogeneous area.

For the present study, involving sampling of rubble and coarse-gravel bottoms, the Surber sampler was used. If significant drift was present in the stream, a blocking screen was used above the sampler. When conditions permitted, two square-foot samples were collected before spraying and from 3 to 4 days after spraying at the time of each of the three treatment periods, and similar samples were taken in July, August and September. All samples were collected by the same person to avoid individual variation in procedure. Sampling times for untreated streams corresponded approximately to those for the post-treatment samples from treated streams, including those in July, August and September.

In order to avoid inclusion of organisms that had died as a result of the larviciding treatment, all samples were picked in the field, using white-bottomed pans and spring forceps, leaving only the living organisms which were transferred to 70 per cent alcohol in labelled vials. Total weights were determined in the laboratory after blotting off any excess liquid, and the average of two samples was used for further evaluation. Extra-large organisms, occurring rarely in the samples, are not included in the results since they would introduce abnormal bias from too infrequent occurrence. The weight data for periods corresponding to the post-treatment and later samplings are presented in Table 1, but the pre-treatment figures are omitted since no corresponding data were available for untreated streams.

Diversity was recorded in terms of families, rather than species, for the four orders, i.e., Plecoptera, Ephemeroptera, Trichoptera and Diptera, expected to be the most sensitive to DDT and other insecticides used in blackfly control. Counts and identification to family were made in the laboratory using the following references: Plecoptera, Ward and Whipple (1959); Ephemeroptera and Trichoptera pupae, Pennak (1953); Diptera, Johannsen (1969) and Ward and Whipple (1959). Families of other orders were also identified and counted, but because of known or re-

TABLE 1. WEIGHT OF LIVE ARTHROPODS IN POST-TREATMENT AND LATER SAMPLES FROM THE STREAMS STUDIED, ACCORDING TO TREATMENT

Year	Treatment	Post-treatment samples						Later samples					
		Period 1		Period 2		Period 3		July		August		September	
		Interval* (days)	Weight (grams)	Interval* (days)	Weight (grams)	Interval* (days)	Weight (grams)	Interval* (days)	Weight (grams)	Interval* (days)	Weight (grams)	Interval* (days)	Weight (grams)
		The Branch											
1961	DDT	0	0.3982	23	0.1156	19	0.3978	..	..	..	..	..	..
1962	DDT	0	0.4609	19	0.3139	18	0.1949	35	0.1459	35	0.2978	29	0.1867
1963	DDT	0	0.1343	19	0.2625	16	0.0182	35	0.1669	28	0.3048	40	0.4563
1964	None	0	0.3279	21	0.4618	21	0.3950	37	0.1740	34	0.3206	26	0.2263
1965	None	0	..	29	0.2752	30	0.1686	33	0.2917	27	0.2644	..	..
1967	None	0	0.070	22	0.218	22	0.096	28	0.103	35	0.132	21	0.147
		Niagara Brook											
1961	DDT	0	0.6577	23	0.5242	24	0.2016	27	0.1342	36	0.7444	37	0.9639
1963	DDT	0	1.4548	19	0.6567	16	0.4334	35	0.4290	28	0.5469	40	0.5689
1964	None	0	0.6363	21	0.9741	20	0.6290	37	0.6573	35	0.6397	26	0.8450
1965	None	0	0.7691	29	1.1887	30	0.7419	33	2.1300	27	1.3298	..	..
1966	MOCl	0	1.4986	16	0.9020	42	0.7489	34	0.4662	37	1.8019	..	..
1967	None	0	0.670	22	0.766	22	0.360	28	0.341	35	0.112	21	0.471
1968	None	0	..	19	0.851	26	1.345	36	0.681	37	0.675	..	..
1969	None	0	1.373	35	1.069	36	2.282	..	..	56	0.501	..	..
1970	None	0	0.671	15	0.478	23	1.125	25	0.834	36	0.763	..	..
1971	None	0	..	21	0.519	15	1.018	40	0.538	..	..	79	0.916
		Schroon River											
1961	DDT	0	0.8255	23	0.2434	18	0.5617	33	0.3411	36	0.3081	..	..
1962	DDT	0	0.8594	17	0.2809	19	0.4412	36	0.3738	35	0.8776	29	0.4544
1963	DDT	0	1.4986	14	0.3967	15	0.8916	35	1.1066	27	0.5249	43	0.7346
1964	None	0	0.2821	20	0.6294	21	0.6312	38	0.7155	35	0.5891	25	0.6835
1965	None	0	0.3016	29	1.2753	30	1.1909	33	0.7226	27	0.8789	..	..
1966	MOCl	0	0.7634	16	0.2901	42	0.6666	34	0.6989	37	0.7039	..	..
1967	None	0	0.340	22	0.645	22	0.615	28	0.512	35	0.355	21	0.468
		Upper East Stony Brook§											
1967	MOCl	0	1.091	6	1.500	37	0.380	30	0.164	32	0.312	30	0.926
1968	MOCl	0	1.150	15	0.572	28	1.186	29	0.794	15	0.648	34	0.413

Middle East Stony Brook§													
1967	MOCl	0	0.654	6	0.673	37	0.555	30	0.218	32	1.036	30	0.558
1968	MOCl	0	0.541	15	0.907	28	0.342	29	0.407	15	0.765	34	0.469
Lower East Stony Brook§													
1967	MOCl	0	1.070	6	0.711	37	0.119	30	0.295	32	0.253	30	0.347
1968	MOCl	0	0.523	15	1.042	28	0.280	29	0.182	15	0.335	34	0.203
Trout Brook													
1962	DDT	0	0.4674	17	1.0243	19	0.1661	36	0.1444	35	0.3392	28	0.7057
1963	DDT	0	0.7259	19	0.4101	16	0.1894	35	0.3391	27	0.3558	41	0.3558
1964	None	0	0.5210	22	0.8271	21	0.4908	36	0.6673	36	0.6195	24	0.3475
1965	None	0	0.2882	29	0.2098	30	0.7529	33	0.7899	27	0.6754	..	..
1966	None	0	1.3052	16	0.7993	42	0.3678	34	0.5099	37	1.0005	..	..
1967	None	0	1.100	22	0.580	22	0.282	28	1.245	35	0.237	21	1.270
1968	None	0	0.434	34	0.811	27	1.747	36	1.562	35	0.266	..	..
1969	MOCl	0	0.270	..	..	35	0.728	36	0.667	56	0.648	..	..
1970	MOCl	0	0.682	14	0.185	24	1.740	25	1.139	37	0.489	..	..
1971	MOCl	0	..	14	0.207	15	0.405	48	0.378	..	..	71	0.846
Paragon Brook													
1962	DDT	0	0.8332	16	0.3990	19	0.2261	35	0.1692	35	0.3554	28	0.5143
1963	DDT	0	1.5238	13	1.9376	17	0.8913	35	0.8228	26	2.2401	42	1.2373
1964	None	0	1.1542	33	1.6584	19	0.4797	37	1.0299	36	2.5584	24	1.0950
1965	None	0	2.5182	29	1.9491	30	2.2478	33	1.1844	27	3.5143	..	..
1966	None	0	3.1829	16	2.1366	42	1.4882	34	0.4068	37	3.9265	..	..
1967	None	0	2.885	22	3.432	22	0.949	28	0.528	35	1.496	21	1.577
1968	None	0	..	34	0.434	27	1.770	..	..	36	1.600	35	0.924
1970	MOCl	0	..	15	0.212	23	0.187	25	0.349	37	0.399	..	..
1971	MOCl	0	..	16	0.115	15	0.396	40	0.176	..	..	79	0.603

*Time after immediately preceding sample; approximately same schedule used where treatment not authorized.

§In 1968, a fourth "later sample" was taken on Upper, Middle and Lower East Stony Brooks at intervals of 32, 32 and 30 days, respectively, after the preceding sample. The corresponding weights recorded were 0.558, 1.169 and 1.956 grams.

ported resistance to DDT or other insecticides they are not included in this paper. In the case of counts, the data for the two samples in each set were combined so that the sum represented a 2-square-foot sample.

Treatment of Data

Weights of the samples varied widely from year to year even in the same stream. High or low weights in initial samplings tended to remain so in both treated and untreated streams through the sampling period. Variation appeared to fall within the range of sampling error. This indicated a positive correlation between populations in the spring and those throughout the sampling period.

Table 2 was constructed from the data for samples from three post-treatment periods or similar samples where treatment was not authorized. These were tabulated according to type of treatment, or lack of treatment. In each case, the first sample was considered as 100 per cent, and the second and third samples were calculated as percentages of the first, and these values were averaged for each type of treatment to reduce individual sampling error. These averages were used to calculate a theoretical first-period sample weight where it was unavailable and to obtain a more accurate figure for the usually highly variable first post-treatment period weight. This permitted comparison of different years and treatments not otherwise possible.

As the intervals between samplings were not uniform, weighted averages were used to calculate an average daily standing crop (as percentage of the calculated initial weight) and, assuming a straight-line relationship, the change over the intervals between samplings. These were calculated, for each stream and type of treatment, for the time period corresponding to post-treatment sampling (the treatment period) and for the complete seasonal samplings. Averaging these periods for each type of treatment produced a figure for the average effect of each chemical used or for no chemical use. "Students" *t*-test for a significant difference of the means (Snedecor, 1956) was used to determine if a treatment had significantly affected the population averages.

Another measurement of the effect of treatment is the resultant degree of alteration in the diversity of organisms present. Percentage overlap has been used to determine significant differences between species and numbers found at stations and could theoretically be used to determine similar differences between treatments using families rather than species. A similarity of 50 per cent or more is usually considered to indicate no significant difference. In the present study it was found too sensitive to numbers and to be unusable when extremely abundant and apparently tolerant species are present. In the four orders used for comparison, representatives of the families Baetidae and Heptageniidae were so abun-

TABLE 2. CALCULATED VALUES FOR SECOND AND THIRD POST-TREATMENT SAMPLES, AS PERCENTAGE OF WEIGHT OF FIRST SAMPLE, ACCORDING TO TREATMENT

Stream	Year	Weight of first sample (grams)	Calculated value (per cent)	
			Period 2	Period 3
Untreated				
The Branch	1964	0.3279	140.8	120.5
	1967	0.070	311.4	137.1
Niagara Brook	1964	0.6363	153.1	98.9
	1965	0.7691	154.5	96.4
	1967	0.670	114.3	53.7
	1969	1.373	77.9	166.2
	1970	0.671	71.4	167.7
Schroon River	1964	0.2821	223.1	223.8
	1965	0.3016	422.8	394.8
	1967	0.340	189.7	180.9
Trout Brook	1964	0.5210	158.8	94.2
	1965	0.2882	72.8	261.2
	1966	1.3052	61.8	28.2
	1967	1.100	52.7	25.6
	1968	0.434	186.9	402.5
Paragon Brook	1964	1.1542	143.7	41.6
	1965	2.5182	77.4	89.3
	1966	3.1829	67.1	46.8
	1967	2.885	119.0	32.9
Average			147.3	140.1
DDT-treated				
The Branch	1961	0.3982	29.0	99.9
	1962	0.4609	68.1	42.3
	1963	0.1343	195.5	13.6
Niagara Brook	1961	0.6577	79.7	39.7
	1963	1.4548	44.4	29.8
Schroon River	1961	0.8255	29.5	68.0
	1962	0.8594	32.7	51.3
	1963	1.4986	26.5	59.5
Trout Brook	1962	0.4674	219.1	35.5
	1963	0.7259	56.5	26.1
Paragon Brook	1962	0.8332	47.9	27.1
	1963	1.5238	127.2	58.5
Average			79.7	45.0
Methoxychlor-treated				
Niagara Brook*	1966	1.4986	60.2	65.1
Schroon River*	1966	0.7634	38.0	87.3
Trout Brook	1969	0.270	..	269.6
	1970	0.682	27.1	255.1
Upper East Stony Brook	1967	1.091	137.5	34.8
	1968	1.150	49.7	103.1
Middle East Stony Brook	1967	0.654	102.9	84.9
	1968	0.541	167.7	63.2
Lower East Stony Brook	1967	1.070	66.5	77.5
	1968	0.523	199.5	53.5
Average			94.3	109.4

*Only two spray applications made.

dant that they almost invariably exceeded 50 per cent of the total numbers of all families present. Wide variation in numbers and even elimination of other families were often completely hidden when this method of measurement was used, and it was thus considered mathematically unjustifiable.

Wilhm (1967) tested a number of diversity indices on samples from a stream receiving both industrial and sanitary sewage. He concluded that Margalef's index:

$$d = (S-1)/\log_n N$$

in which, d = diversity
S = number of species represented in sample
N = number of individuals in sample

had the highest coefficient of correlation with number of species and effectively distinguished between stations. Its application herein to the four orders expected to be the most sensitive to DDT and other insecticides used in blackfly control is an attempt to demonstrate whether an actual effect on the populations of these arthropods resulted from treatment. The use of families rather than species would make this index less sensitive so that any significant difference would be important. As for the weight data, the *t*-test was used to determine significant differences of the means for the Margalef index for each treatment. These were calculated for the treatment period and for the entire season.

RESULTS

The results reported in this paper are applicable only to comparable dosages delivered by fixed-wing aircraft. The effect of treatment on the weighted average of daily standing crops as percentage of the adjusted sample weights for the first post-treatment period are shown in Table 3 for the treatment period and in Table 4 for the entire sampling period.

It is recognized that unauthorized applications may have occurred from time to time in certain streams, since during part of the study period treatment chemicals could be readily obtained. Additional treatment may also have occurred in localized areas on some of the treated streams. Also, slight differences in the point of stream crossing during the aerial applications, especially where the station chosen was close to the upper boundary of the area, could have reduced or even eliminated the effect of treatment on some samplings. Although the data might indicate this to have occurred on a few occasions, no corrections were made. Ascribing such occurrences to sampling error, these data have been included in the records for the intended type of treatment.

The average daily standing crop during the treatment period (roughly late April to July), as percentage of the adjusted data for the first post-treatment period, was found to be 133.2 per cent for untreated streams, 74.3 per cent for streams treated with DDT and 101.8 per cent for those treated with methoxychlor. The corresponding values for the entire sampling period were 138.8, 70.6 and 109.3 per cent, respectively. This seems to indicate that DDT had a continuing and more persistent effect for some time after cessation of treatment than did methoxychlor.

Using the method of Snedecor (1956) for determining *t*-values for

TABLE 3. AVERAGE DAILY STANDING CROP OF ARTHROPODS IN TREATMENT PERIOD, AS PERCENTAGE OF WEIGHT OF FIRST SAMPLE, ACCORDING TO TREATMENT

Stream	Year	Number of post-treatment samples	Total interval (days)	Average daily standing crop (per cent)*
Untreated				
The Branch	1964	3	42	135.8
	1965	2	59	142.1
	1967	3	44	148.3
Niagara Brook	1964	3	41	140.8
	1965	3	59	141.5
	1967	3	44	146.6
	1968	2	45	127.0
	1969	2	35	120.6
	1970	3	38	122.5
	1971	2	36	116.5
Schroon River	1964	3	41	132.9
	1965	3	59	134.0
	1967	3	44	133.5
Trout Brook	1964	3	43	142.6
	1965	3	59	111.8
	1966	3	58	146.2
	1967	3	44	146.0
	1968	2	61	115.9
Paragon Brook	1964	3	42	156.6
	1965	3	59	99.6
	1966	3	58	141.7
	1967	3	44	154.9
	1968	2	61	106.0
Average				133.2
DDT-treated				
The Branch	1961	3	42	56.1
	1962	3	37	74.9
	1963	3	35	100.4
Niagara Brook	1961	3	47	81.3
	1963	3	35	74.7
Schroon River	1961	3	41	59.6
	1962	3	36	62.2
	1963	3	29	58.9
Trout Brook	1962	3	36	90.8
	1963	3	35	80.3
Paragon Brook	1962	3	35	74.9
	1963	3	30	77.0
Average				74.3
Methoxychlor-treated				
Niagara Brook§	1966	3	58	89.3
Schroon River§	1966	3	58	139.3
Upper East Stony Brook	1967	3	43	101.2
	1968	3	43	96.9
Middle East Stony Brook	1967	3	43	101.1
	1968	3	43	106.0
Lower East Stony Brook	1967	3	43	101.2
	1968	3	43	107.4
Trout Brook	1969†	2	35	104.8
	1970	3	38	90.3
	1971	3	29	94.8
Paragon Brook	1970‡	2	38	101.9
	1971‡	2	31	89.2
Average				101.8

*Represents average weight of second and third post-treatment samples calculated as percentage of weight of first sample.
§Only two spray applications made.
†Second post-treatment sample not collected.
‡First post-treatment sample not collected (stream high).

Table 4. Average Daily Standing Crop of Arthropods Over Entire Sampling Period, as Percentage of Weight of First Sample, According to Treatment

Stream	Year	Number of samplings	Total interval (days)	Average daily standing crop (per cent)*
Untreated				
The Branch	1964	6	139	104.0
	1965	5	119	153.1
	1967	6	128	121.8
Niagara Brook	1964	6	139	126.7
	1965	5	119	187.5
	1967	6	128	98.3
	1968	6	118	116.3
	1969	5	127	175.9
	1970	5	99	142.4
	1971	5	155	132.6
Schroon River	1964	6	139	145.4
	1965	5	119	118.6
	1967	6	128	116.2
Trout Brook	1964	6	139	131.3
	1965	5	119	167.3
	1966	5	129	148.3
	1967	6	128	215.7
	1968	5	132	130.7
Paragon Brook	1964	6	149	179.3
	1965	5	119	98.3
	1966	5	129	133.1
	1967	6	128	99.2
	1968	5	132	150.7
Average				138.8
DDT-treated				
The Branch	1962	6	136	57.3
	1963	6	138	123.7
Niagara Brook	1961	6	147	89.9
	1963	6	138	60.7
Schroon River	1961	5	110	53.3
	1962	6	136	78.1
	1963	6	134	62.9
Trout Brook	1962	6	135	49.9
	1963	6	138	71.8
Paragon Brook	1962	6	133	62.2
	1963	6	133	67.0
Average				70.6
Methoxychlor-treated				
Niagara Brook	1966	5	129	90.8
Schroon River	1966	5	129	186.5
Upper East Stony Brook	1967	6	135	58.5
	1968	7	153	83.7
Middle East Stony Brook	1967	6	135	99.6
	1968	7	153	98.3
Lower East Stony Brook	1967	6	135	73.5
	1968	7	153	82.3
Trout Brook	1969	4	127	101.4
	1970	5	100	108.4
	1971	5	148	161.1
Paragon Brook	1970	5	100	142.6
	1971	5	150	134.7
Average				109.3

*Represents average weight of second and later post-treatment samples calculated as percentage of weight of first sample.

TABLE 5. COMPARISON OF DIFFERENT TREATMENTS, ACCORDING TO *t*-VALUE FOR DIFFERENCE OF MEANS OF AVERAGE DAILY STANDING CROP* OF ARTHROPODS, FOR TREATMENT PERIOD AND ENTIRE SEASON

Comparison	Treatment period		Entire season	
	t-value	Probability	*t*-value	Probability
Untreated—DDT	9.349	<0.001§	7.302	<0.001
Untreated—methoxychlor	5.131	<0.001	2.396	<0.05
Methoxychlor—DDT	5.228	<0.001	3.222	<0.01

* As percentage of data for first post-treatment period.
§ Much less.

samples of unequal size and different standard deviations, all sample means of different treatments were found to differ significantly, greater differences occurring during the treatment period. Comparisons of the values of "*t*" and its probability of chance occurrence are given in Table 5 for the treatment period and for the entire season. That the probability of chance occurrence, in the comparison of samples from untreated and methoxychlor-treated streams, was greater for the data from the entire season was due to greater variability in the samples and recovery which occurred quite rapidly in some streams after methoxychlor treatment. In the comparison between methoxychlor and DDT, the greater probability for the data from the entire season was due largely to greater variability, since DDT continued to decrease and the methoxychlor average increased.

With respect to diversity, each sample consisted of two square-foot samples, counted separately but combined for tabulation and analysis. As previously noted, the families of certain orders were substituted for species in the equation for Margalef's index. The data and the diversity values are given in Table 6. The *t*-test for significant differences in the means of the diversity values indicated an alteration only in the comparison between untreated and methoxychlor-treated streams. This held true both in the treatment period and for the entire season. The comparative data are given in Table 7.

This would appear to indicate that methoxychlor had a greater effect than DDT on diversity. This assumption might be questionable, however, since the values for Trout Brook in 1962 were highly aberrant. For this one year on this stream, the values for diversity during the treatment period were the highest of those for any stream either treated or untreated. Also, for Trout Brook itself, they were 43 per cent higher than the average for the five years when the stream was untreated, 74 per cent higher than the average for the three years when it was treated with methoxychlor and 80 per cent higher than the value during the only other year when it was treated with DDT. If this stream had been

Table 6. Diversity Values, Derived by Margalef's Index*, for the Various Samples According to Treatment

Stream	Year	Post-treatment samples									Ave.	Later samples									Ave.	Tot. ave.
		Period 1			Period 2			Period 3				July			August			September				
		S	N	d	S	N	d	S	N	d	d	S	N	d	S	N	d	S	N	d	d	d
Untreated§																						
Niagara Brook	1964	11	70	2.35	10	146	1.81	11	149	2.00	2.05	11	84	2.26	11	151	1.99	14	306	2.27	2.17	2.11
	1965	12	130	2.26	12	198	2.08	12	76	2.54	2.29	14	187	2.49	11	149	2.00	..	..	..	2.25	2.27
	1967	10	63	2.17	8	92	1.59	7	74	1.39	1.72	8	68	1.66	8	28	2.10	14	88	2.90	2.22	1.97
	1968	..	..	..	10	168	1.76	14	211	2.43	2.20	14	211	2.43	15	84	3.16	14	87	2.91	2.80	2.50
	1969	13	189	2.29	13	138	2.44	12	332	1.89	2.21	12	332	1.89	..	..	..	13	50	3.07	2.43	2.32
	1970	13	110	2.55	8	64	1.68	17	237	2.93	2.39	12	89	2.45	17	104	3.45	..	..	..	2.95	2.67
	1971	..	..	..	9	33	2.29	11	80	2.28	2.29	11	102	2.16	..	..	..	11	91	2.22	2.19	2.24
Schroon River	1964	8	91	1.55	10	86	2.02	9	140	1.62	1.73	11	144	2.01	12	146	2.21	14	405	2.17	2.13	1.93
	1965	9	71	1.88	12	346	1.88	12	208	2.06	1.94	12	149	2.20	14	117	2.73	..	..	..	2.47	2.21
	1967	6	73	1.17	7	107	1.28	5	22	1.29	1.25	7	41	1.62	6	56	1.24	10	93	1.99	1.62	1.44
Trout Brook	1964	10	88	2.01	9	183	1.54	11	115	2.11	1.89	12	221	2.04	10	136	1.83	13	271	2.14	2.00	1.95
	1965	9	48	2.07	7	84	1.35	11	104	2.15	1.86	12	295	1.93	18	199	3.21	..	..	..	2.57	2.22
	1966	17	173	3.10	15	112	2.97	15	89	3.12	3.06	15	89	3.12	9	79	1.83	14	182	2.50	2.48	2.77
	1967	13	121	2.50	10	74	2.09	10	44	2.38	2.32	16	146	3.01	12	45	2.89	14	145	2.61	2.84	2.58
	1968	..	..	..	11	129	2.06	12	178	2.12	2.09	12	178	2.12	15	101	3.03	14	80	2.97	2.71	2.40
Paragon Brook	1964	11	101	2.17	13	260	2.16	9	95	1.76	2.03	11	262	1.79	11	570	1.58	13	404	2.00	1.79	1.91
	1965	11	433	1.65	11	349	1.77	12	106	2.36	1.93	12	160	2.17	15	399	2.34	..	..	..	2.26	2.20
	1966	12	442	1.81	11	337	1.72	14	147	2.61	2.05	14	147	2.61	10	176	1.74	9	357	1.36	1.90	1.98
	1967	12	192	2.09	13	266	2.15	10	90	2.00	2.08	12	77	2.53	9	82	1.82	15	188	2.68	2.34	2.21
	1968	..	..	..	10	40	2.44	14	108	2.77	2.61	14	108	2.77	14	155	2.58	11	71	2.35	2.57	2.59
Average		11.1	xxx	2.10	10.9	xxx	1.95	11.3	xxx	2.19	2.10	12.1	xxx	2.26	11.9	xxx	2.32	12.8	xxx	2.41	2.33	2.22
DDT-treated																						
Niagara Brook	1961	10	123	1.86	6	67	1.19	6	65	1.20	1.42	9	115	1.69	12	199	2.08	12	204	2.07	1.95	1.69
	1962	7	39	1.63	8	39	1.91	11	129	2.06	1.87	7	83	1.37	14	206	2.44	9	155	1.59	1.80	1.84
	1963	12	160	2.15	11	85	2.25	9	63	1.93	2.11	8	109	1.49	12	303	1.92	14	263	2.33	1.91	2.01
Schroon River	1961	14	74	3.02	7	84	1.35	7	139	1.22	1.86	12	156	2.18	13	202	2.26	..	..	..	2.22	2.04
	1962	12	99	2.39	9	82	1.82	7	116	1.26	1.82	10	191	1.71	11	128	2.06	9	139	1.62	1.80	1.81
	1963	13	253	2.17	11	146	2.01	9	125	1.66	1.95	13	245	2.18	12	189	2.10	14	245	2.36	2.21	2.08

Paragon Brook	1962	7	56	1.49	7	62	1.45	5	26	1.23	1.39	6	75	1.16	9	258	1.44	10	214	1.68	1.43	1.41
	1963	10	331	1.55	10	235	1.65	6	51	1.27	1.49	8	219	1.30	11	302	1.75	10	680	1.38	1.48	1.49
Trout Brook	1962	13	44	3.17	17	122	3.33	13	46	3.13	3.21	13	134	2.45	15	253	2.53	13	197	2.27	2.42	2.82
	1963	12	132	2.25	9	95	1.76	6	42	1.34	1.78	9	82	1.82	16	234	2.75	15	581	2.20	2.26	2.02
Average		11.0	xxx	2.17	9.5	xxx	1.87	7.9	xxx	1.63	1.89	9.5	xxx	1.74	12.5	xxx	2.13	11.8	xxx	1.94	1.95	1.92
Methoxychlor-treated																						
Niagara Brook†	1966	14	234	2.38	9	99	1.74	..	..	..	2.06	12	174	2.13	10	69	2.13	15	211	2.62	2.29	2.18
Schroon River†	1966	9	239	1.46	6	49	1.28	..	..	..	1.37	9	42	2.14	7	64	1.44	12	109	2.34	1.97	1.67
Trout Brook	1969	9	52	2.02	..	..	..	10	69	2.13	2.08	11	103	2.16	..	..	..	16	122	3.12	2.64	2.36
	1970	7	20	2.00	6	60	1.22	11	170	1.95	1.72	13	81	2.73	14	115	2.74	..	..	..	2.74	2.23
	1971	..	..	..	6	22	1.62	9	74	1.86	1.74	9	74	1.86	..	..	..	14	324	2.25	2.06	1.90
Paragon Brook	1970	..	..	..	5	43	1.06	10	61	2.19	1.63	10	100	1.95	10	76	2.08	..	..	..	2.02	1.83
	1971	..	..	..	4	24	0.94	5	65	0.96	0.95	5	14	1.52	..	..	..	11	109	2.13	1.83	1.39
Upper East Stony Br.	1967	12	144	2.21	15	256	2.52	10	91	2.00	2.24	8	55	1.75	10	82	2.04	7	125	1.24	1.68	1.96
	1968	8	64	1.68	6	89	1.11	9	148	1.60	1.46	8	89	1.56	12	98	2.40	10	242	1.64	1.87	1.69
Middle East Stony Br.	1967	6	66	1.19	11	96	2.19	10	133	1.84	1.74	7	57	1.48	13	242	2.18	10	79	2.06	1.91	1.83
	1968	12	59	2.70	10	87	2.02	6	36	1.67	2.06	10	99	1.96	10	127	1.86	11	184	1.92	1.91	2.02
Lower East Stony Br.	1967	9	69	1.39	10	88	2.01	8	72	1.64	1.85	9	56	1.99	6	60	1.24	6	91	1.11	1.45	1.65
	1968	10	49	2.31	9	77	1.84	8	28	2.10	2.08	7	35	1.69	13	88	2.68	11	300	1.75	2.04	2.06
Average		9.6	xxx	1.98	8.1	xxx	1.63	8.8	xxx	1.81	1.77	9.1	xxx	1.76	10.5	xxx	2.08	11.2	xxx	2.02	2.03	1.90

*See text for index equation and definition of symbols, except that as used in this table "*S*" represents families instead of species.
§On untreated streams, samples were taken at intervals corresponding to those used on the treated streams.
†Only two spray applications made.

Table 7. Comparison of Different Treatments, According to *t*-value for Difference of Means of Diversity Values, for Treatment Period and Entire Season

Comparison	Treatment period		Entire season	
	t-value	Probability	*t*-value	Probability
Untreated—DDT	1.41	<0.2	2.013	<0.1
Untreated—methoxychlor	2.144	<0.025	3.019	<0.025
Methoxychlor—DDT	0.625	>0.5	0.017	>0.5

more in line with the other streams, significant differences would have been found for comparisons between untreated and DDT-treated streams as well. The reason for the aberration is unknown.

CONCLUSIONS

Treatment produced a definite effect on the average daily standing crop of arthropods in terms of percentage of the initial calculated weight at the first post-treatment period. The mean of these figures for all similarly treated streams indicated that, for the treatment period, DDT reduced the average daily standing crop by 44.2 per cent and methoxychlor reduced it by 23.6 per cent, compared with untreated streams. DDT reduced the average daily standing crop 27.0 per cent more than did methoxychlor. Corresponding figures for this reduction over the entire sampling period were 49.1 per cent for DDT and 21.3 per cent for methoxychlor. Over the season, the average daily standing crop was reduced 35.4 per cent more by DDT than by methoxychlor.

On the basis of these figures it could be concluded that the effect of DDT treatment is more persistent and recovery is less rapid than in the case of methoxychlor. This is tenable only as it refers to the dosages of the two chemicals used in this study. There is no basis for assuming that this relationship would have existed if methoxychlor had been used in a 20 per cent solution instead of the 15 per cent actually used.

Average daily standing crop appears to be a better estimation of the average effect of treatment on streams than does the Margalef diversity index applied to families rather than species. Although the means for untreated and methoxychlor-treated streams were significantly different (probability <0.025) for both the treatment period and for the entire season (Table 7), the average during the two periods was 15.7 and 14.4 per cent less, respectively, in the treated streams than in the untreated streams (Table 6). The extremely aberrant values for Trout Brook when treated with DDT in 1962, which prevented the average for this type of treatment from being significantly different from that for no treatment, may have been caused by using families rather than species for the *S*-value in calculating the index. Unless a family is represented by only a single species or by a single specimen, sensitivity is reduced. If the

number of species were double the number of families, the index based on species would be nearly twice what it would be if families were used. If treatment were to remove half the species, the index would not be affected. The only conclusion that can be drawn on the basis of this study is that this index, even using as course a measurement as families, indicated that treatment had some effect on diversity. However, its sensitivity is not great enough to justify the effort involved.

The number of families represented in the homogeneous central portion of the stream was also affected by treatment as evidenced in Table 6 by the average number found per sampling. The mean of these averages during the treatment period was 11.1 families for untreated streams and 9.5 and 8.8, respectively, for DDT-treated and methoxychlor-treated streams. For the entire season, the corresponding means were 11.7, 10.4 and 9.6. Since recovery occurred by the next season, if not earlier, the difference is considered to have been due to a reduction in the abundance of some families in the sampling area rather than to the elimination of these families in the stream. Recovery could not have been as rapid if families had been eliminated.

The reduction in stream productivity associated with the treatments made was found to be greater than had been anticipated. With respect to the supply of trout food, such a reduction could be critical if it occurred in the late fall. In the present study, the times of treatment coincided well with a period of increased terrestrial drift which compensated, in part, for the reduction in weight of the standing crop of arthropods in the stream during this period.

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STATUS OF THE OSPREY, BALD EAGLE AND GOLDEN EAGLE IN THE ADIRONDACKS [1]

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ABSTRACT

A survey of nesting ospreys, bald eagles and golden eagles in the Adirondacks was made in 1970, 1971 and 1972. The osprey population in 1972 was estimated as 55 birds. Active nests observed (16, 18 and 25 for the three years, respectively) fledged an average of 0.34 (0.17 to 0.58) young per nesting attempt, or about one-third that required for population stability. The bald eagle population, which had been estimated at a minimum of eight pairs in 1952, was felt to have disappeared. Only two pairs of golden eagles were known to be present in 1972. The mechanism for nesting failure in the osprey was failure of eggs to hatch, many pairs incubating as much as 21 to 34 days past the expected hatching date before deserting. The mechanism for population decline in the eagles is not known, although both nesting failure and reduction in suitable habitat have been noted for the golden eagle.

Serious declines in the populations of several raptorial and fish-eating birds in North America have occurred in the last 20 years (Hickey, 1969). In some cases the decline has been correlated with nesting failure and the use of certain insecticides, and experimental feeding of such substances to birds of this sort has resulted in reduced eggshell thickness and low egg viability similar to what has been associated with nesting failure in the wild (Porter and Wiemeyer, 1969). The disappearance of the peregrine falcon from northern New York (Spofford, 1969a; Kelsey, 1965) created concern for other birds in the Adirondack region, and a population survey of the osprey (*Pandion haliactus*) was undertaken in 1970. The osprey was selected as a possible indicator species for the presence of any chemical contamination in the region that might adversely affect fish-eating birds. The accumulation of data on the status of the bald eagle (*Haliactus leucocephalus*) and golden eagle (*Aquila chrysaetos*) was a by-product of the osprey survey.

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THE SURVEY AREA

The survey was carried on principally in the Adirondack Park (i.e., within the so-called "blue line"), an area of some 6,000,000 acres, although a few osprey nests were observed in the vicinity of the Indian River in Jefferson and St. Lawrence Counties. An insignificant proportion of the Park is cultivated, while the majority is forested land. Private lands (about 61 per cent) may be lumbered, but State-owned lands constitute the Forest Preserve on which timber cutting is prohibited by the State Constitution. The region is famous for recreation and vacationing, and many private holdings are classified as seasonal residences.

The Adirondacks constitute an uplifted portion of the Laurentian shield characterized by rugged, mountainous terrain interspersed with numerous clear streams, ponds and lakes. Elevations range from 100 feet above sea level along Lake Champlain to over 4,200 feet on several mountain peaks including Mt. Marcy, the highest, at 5,344 feet. In general, five principal river drainages, the Hudson, Black, Sacandaga, Oswegatchie and Saranac, originate in the central Adirondacks and flow toward the periphery. The climate is characterized by wet, warm summers and cold winters with an annual precipitation of 30 to 60 inches (Mordoff, 1949). The nature of the forest has been described by Smith (1955).

> "In general, the area below 1,500 feet is occupied by a northern hardwood forest of beech, yellow birch, sugar maple, hemlock, and paper birch, with an admixture of balsam fir and red spruce. The heart of the area is predominantly spruce, fir, and birch, becoming a stunted forest of spruce, fir, and paper birch on the exposed summits. On the highest peaks occurs the so-called Alpine flora, representing shrubs and herbs of the treeless areas far to the north. On the sands of the Black River valley, and on the lowlands east of the higher mountains especially, white pine is an important species, being able to maintain itself against the hardwoods."

On areas that have been burned, bracken fern and blueberries tend to predominate, together with aspen and pin cherry. Locally, marshes and bogs (vlys) are an important feature, and beaver ponds occur along many streams. The bogs are frequently surrounded by coniferous swamps.

With respect to food sources of the osprey and bald eagle, the fishes of the region have been noted by Kendall and Dence (1929), Greeley (1930, 1934) and Greeley and Bishop (1932, 1933). Prey species of the golden eagle (and bald eagle) include the small birds and mammals typical of the forests of the Northeast, as well as white-tailed deer which may be occasionally taken or become available as carrion.

METHODS

As has been noted, the work was undertaken as a survey of the osprey population; observations concerning eagles were made incidentally during the course of field work. Information regarding the location of osprey nests was first solicited from local residents, amateur ornithologists, forest rangers and Department biologists, and was supplemented by ground, boat and airplane surveys. Nests were checked twice each season, once between May 10 and 25 to look for incubation activity and again between July 10 and 25, when the adults were not brooding, to examine active nests for the presence of large young. The majority of these checks were made from a Cessna 185 airplane, while ground checks were made with the aid of binoculars and a 20X scope. It was found that both the aerial and ground surveys were needed for accurate counts. Only a small number of nest trees were climbed, since active nests were invariably located in trees that were not suitable for climbing due to their height, fragility or remoteness.

Features described by Mathisen (1968) were used to recognize osprey nests, and the definitions provided by the Raptor Research Foundation (Anonymous, 1969) were used to identify active and successful nests.

Active nest: a nest at which eggs were laid and adult birds were seen in an incubating or brooding position, or in which young in a pre-flight stage of development were seen

Successful nest: a nest at which at least one egg hatched and at least one nestling was seen in an advanced stage of development (just prior to fledging time), or an active nest at which fledglings were seen

These definitions were also used for eagle nests.

OSPREY

The osprey is widespread but not a common bird in the Adirondacks, where it usually arrives in April and departs in October. Its food consists almost exclusively of fish. Osprey nests are bulky structures, generally in a treetop or on a dead stub. Individual nests are often used for many years, the longest known record in the Adirondacks being at least 34 years (personal observation of William Marleau, forest ranger) for a nest near Big Moose Lake. This nest blew down during the survey. The same pair of birds usually returns year after year to the same site. Clutches vary from two to four eggs, but three is by far the most frequent number.

Characteristics of Nesting Population

The distribution of the 39 nesting territories recorded is shown in Figure 1. Each territory represented either a single nest or a cluster of two to

Figure 1. Distribution of the 39 recorded osprey nesting territories in northern New York. Solid circles represent those in which one or more nests were active in 1970, 1971 or 1972.

four attributed to the same pair of ospreys. Based on the 73 nests existing in 1972, the overall average was 1.87 per pair. The use of a nest in alternate or less frequent, rather than successive, years, and the building of "frustration" nests as suggested by Postupalsky (1968), may be reasons for the extra nests. The only concentration of active nests observed was at Little Tupper Lake on Whitney Park where an average of 2.6 miles separated four such nests in 1972. Elsewhere, active nests ranged from 4.5 to 20 miles from each other. Those of four pairs in the vicinity of the Indian River (in Jefferson and St. Lawrence Counties) averaged 6.3 miles apart.

Nesting situations were in lowland areas, usually on a lake shore or small island, in a stillwater or beaver flow, or along a watercourse. Often they were in overmature timber. Of the 81 nests inspected (including those that later blew down), 36 were in dead white pine, 31 in live white pine (many with dead tops), five in dead spruce, five in dead unidentified coniferous trees, one in a live spruce, one in a dead tamarack, one in a red maple and one in a dead balsam fir. With one exception, nests were

Osprey nest in a large white pine. (Plumley Pond, 1970)

in the tops of trees and ranged from 35 to 130 feet above the ground, the majority being between 75 and 90 feet.

Ospreys have been first observed at nests in the spring between April 18 and May 10, often while the larger bodies of water were still ice covered. Nest repair or construction begins immediately. Egg laying takes place during the period from about April 26 to about May 20, and almost all pairs are incubating by May 12. The few observations of fledglings or first flights of young occurred between July 28 and August 4.

Ospreys were most often observed hunting about the shallow-water areas of streams and the shoals and shallows of lakes. Important components of hunting behavior were slow, low-level flight (50 to 100 feet above the water) and alternate intervals of hovering. A total of 23 observed dives into the water resulted in the capture of 15 fish. The longest observed flight to an active nest with a fish was 2.3 miles. Fish identified included white suckers, brown bullhead, bluegill, pumpkinseed, yellow perch, rainbow trout, lake trout and brook trout.

Causes of Nesting Failure

In the 3-year period of study, only 15 of 60 (25 per cent) nesting attempts were successful (Table 1). Of the 45 failures observed, five nests were blown out by the wind while eggs were present, one in 1970, one in 1971 and three in 1972, two of the latter during the strong winds of Hurricane Agnes (June 19-23). The female at one active nest was reported shot by a fisherman in 1970. The remaining 39 failures were

TABLE 1. DISTRIBUTION AND SUCCESS OF OSPREY NESTS IN NORTHERN NEW YORK AS RECORDED DURING SURVEY

County	Number known in 1972	Combined numbers for 3-year period (1970–1972)	
		Active	Successful
Essex	1	1	1
Franklin	25	17	4
Hamilton	28	22	6
Herkimer	7	6	1
Jefferson	5	3	0
Lewis	1	2	0
St. Lawrence	6	9	3
Total	73	60	15

associated with failure of the eggs to hatch. Assuming an incubation period of 38 days (P. F. Spitzer, unpublished data), adults were observed incubating from 21 to 34 days beyond the expected hatching date. On several occasions during aerial observations in mid-July, neglected eggs were seen in nests. More frequently, the eggs disappeared or only fragments were visible, presumably after being broken, popping from decay, or being eaten by the adults or, in cases where neglected, eaten by other birds such as herring gulls or crows. Entirely new nests, sometimes called frustration nests, were built after nesting failure (June 16 to July 8) in six cases, four during 1972.

The tremendous decline in ospreys along the Connecticut River was attributed by Peterson (1969) to a similar mechanism of hatching failure (81 per cent of 185 eggs) with incubation "to no avail" of 60 to 70 days. Further, the reproductive failure of ospreys in sections of the Northeast has been correlated with high concentrations of DDT and dieldrin in the eggs (Spitzer, 1972), while significant reduction of eggshell thickness in a declining population in New Jersey has been related to the presence of chlorinated hydrocarbons (Hickey and Anderson, 1968).

The use of insecticides in the Adirondacks has probably been sufficient to alter reproductive levels of the osprey. Sporadic use of DDT in some sections of the region occurred from the 1940's through the mid-1960's. It was applied by aerial spray for forest pests, while DDT blocks in streams and aerial applications were used for controlling blackflies (Jamnback and Collins, 1955). One result of these applictaions was a reduced productivity among lake trout in Lake George as reported by Burdick et al. (1964). Mack et al. (1964) noted significant concentrations of DDT in several Adirondack fish, including 1.5 ppm in the flesh of brook trout from the vicinity of Newcomb and 18-38 ppm in the visceral fat and testes of largemouth bass from Lake George (near Bolton). Porter and Weimeyer (1969) used similar levels in administering regular diets of

DDT and dieldrin to captive sparrow hawks, significantly reducing their reproduction.

Status

In the area surveyed, there was a known osprey population of 17 nesting pairs in 1970, 18 in 1971 and 25 in 1972. The increase was probably a result of greater survey coverage rather than population change. More nests and pairs may yet be located. An estimated total population in 1972 of 55 ospreys was obtained by adding 10 per cent to the known number of adults (i.e., 25 pairs) to account for unmated adults and immature birds.

Productivity for the three years averaged 0.34 young per active nest (Table 2). This was roughly one-third that of 1.00 young per active nest suggested by the life tables of Henny and Wight (1969) as necessary to

Table 2. Osprey Productivity in Northern New York as Recorded During Survey

	Nests					Young	
				Successful			
Year	Known	Observed	Active	Number	Per cent	Produced	Fledged *
1970	43	43	17	6	35.3	10	0.58
1971	68	57	18	5	38	6	0.33
1972	73	66	25	4	16.0	4	0.16
Average							0.34

* Per active nest.

maintain a stable population. Henny and Ogden (1970) predicted that a population producing at this level would have a 12 to 14 per cent annual decline. No decline, however, was noted in the Adirondacks either in the number of pairs or in the number of active nests over the 3-year period.

There is little likelihood that an extremely large cohort of young was produced in 1968 or 1969 which was replacing what, according to Henny and Wight (1969), must have been an annual adult mortality of about 18 per cent. Greenleaf Chase observed only occasional successful nestings in the 1960's, and John Belknap watched a series of consecutive failures at three nests in the Indian River section from 1964 to 1970. One proposed explanation is that the Adirondack population is not an isolated population and is able to avoid decline by a limited immigration of ospreys attaining breeding age (3 years) from a considerably larger or more productive population in adjacent Quebec and Ontario. Spofford (1969b) reported an increase of ospreys in counts at Hawk Mountain (Penn.) since 1950 even while coastal populations (Connecticut, New York and New Jersey) were disappearing and felt that the increase was due to birds from eastern Canada "for the most part".

BALD EAGLE

No active nests of the bald eagle were located in northern New York during the three years of the survey. Individual eagles were noted during July and August at several locations including Indian Lake, Union Falls Reservoir, Raquette River Flow (Carry Falls Reservoir) and Oseetah Lake.

In the past, bald eagles nested near the larger lakes and reservoirs and were a conspicuous part of the native fauna for many people. Greenleaf Chase described three nests known to him in the 1950's at Follensby Pond, Follensby Jr. Pond and Sargent Ponds. Mark Chellis remembered alternate activity in the 1940's at two nests (Gull Lake and Raquette River Flow) and activity into the 1950's at a nest on Round Lake in the Whitney Park. While these nests were in white pines, other residents have assured me that bald eagles used four nests on ledges at different points in the Adirondacks during the early 1950's. Also, in 1945 George Sandburg with his father and brother climbed a cliff near Stony Point Mountain on Lake Champlain and saw "two eaglets on the ledge nest and the adult bald eagles nearby".

The last definite bald eagle nesting activity that the author was able to learn of occurred at the famous Follensby Pond nest where Joseph Hart saw a pair of adults in courtship on April 2, 1960. Residents of nearby Tupper Lake saw only a single adult for the next four years. Based on the presence of pairs and well verified nests, the minimum population estimate for 1952 is eight pairs. Greenleaf Chase felt that other pairs must have disappeared before 1950, for several nests described to him which blew down in the hurricane of November 25, 1950 were never replaced. In summary, the final decline of the bald eagle as a breeding bird in the Adirondacks took place during the late 1940's and the 1950's, the last activity being observed in 1960.

Little is known of the ecology or behavior of the bald eagle in the Adirondacks, and the cause or causes for its decline are unknown. The same is true of the relation of the bald eagle to the golden eagle in areas where both were resident, particularly in terms of nest sites and food. During the early nesting season (April) the lakes are usually frozen, and the bald eagles may have turned from fish to mammalian prey or carrion. Local residents have reported observing, on several occasions during this season, apparently migrant bald eagles feeding on deer carcasses.

GOLDEN EAGLE

Eaton (1914) found no evidence that the golden eagle had nested within the borders of New York State after 1900, although Spofford (1971) reported the existence of breeding populations in New York and the Appalachians. Observations during the present survey confirmed the

presence of the species in the Adirondacks. One nest, active in 1970, was on a remote cliff in an area where golden eagles were known to have nested on a ledge 72 years earlier.

Two successful nestings and three nesting failures were observed at three different golden eagle nests (Table 3). A nest was discovered on

Table 3. Golden Eagle Productivity in Northern New York as Recorded During Survey

	Nests					Known birds			
						Near known nest		No known nest	
Year	Known	Observed	Decorated	Active	Successful	Paired	Single	(paired)	Total
1970	14	13	5	3	2	10	1	2	13
1971	16	9	4	1	0	8	1	0	9
1972	16	10	2	1	0	4	0	0	4

July 27, 1970 on a remote wilderness cliff that contained no young but retained signs of recent activity, indicating a nesting failure. No decoration or activity by eagles was observed at this nest in 1971 or 1972. Another nest, in a live white pine, was successful in 1970, but incubation was terminated in 1971 and 1972 after several weeks and at a time when hatching was expected or overdue (May 3-7 and May 13-15, respectively). The third nest, on a remote ledge, was successful in 1970 but was not visited after that.

The total known golden eagle population in 1970 was 13 birds, but this was lowered to four in 1972. The cause of this apparent decline was the absence of the pair whose nest had not been known and the absence of any birds being observed or nest decoration at three sites, although these eagles might still have been present and frequenting another area. Without further intensive studies, it is impossible either to be sure that all pairs or nests are known or to determine with certainty that a pair is absent near a known nest. The lack of breeding attempts makes observation difficult.

According to impressions and recollections of residents in the Adirondacks, the golden eagle, while never abundant, was more common and successful as a breeding bird in the past than during the survey years. Spofford (1971) stated "At one Adirondack site on the upper Hudson River, local fishermen have assured me that nesting success was frequent during the 1940's. At another site over a lake frequented by fishermen, young were watched in the nest many times before 1950."

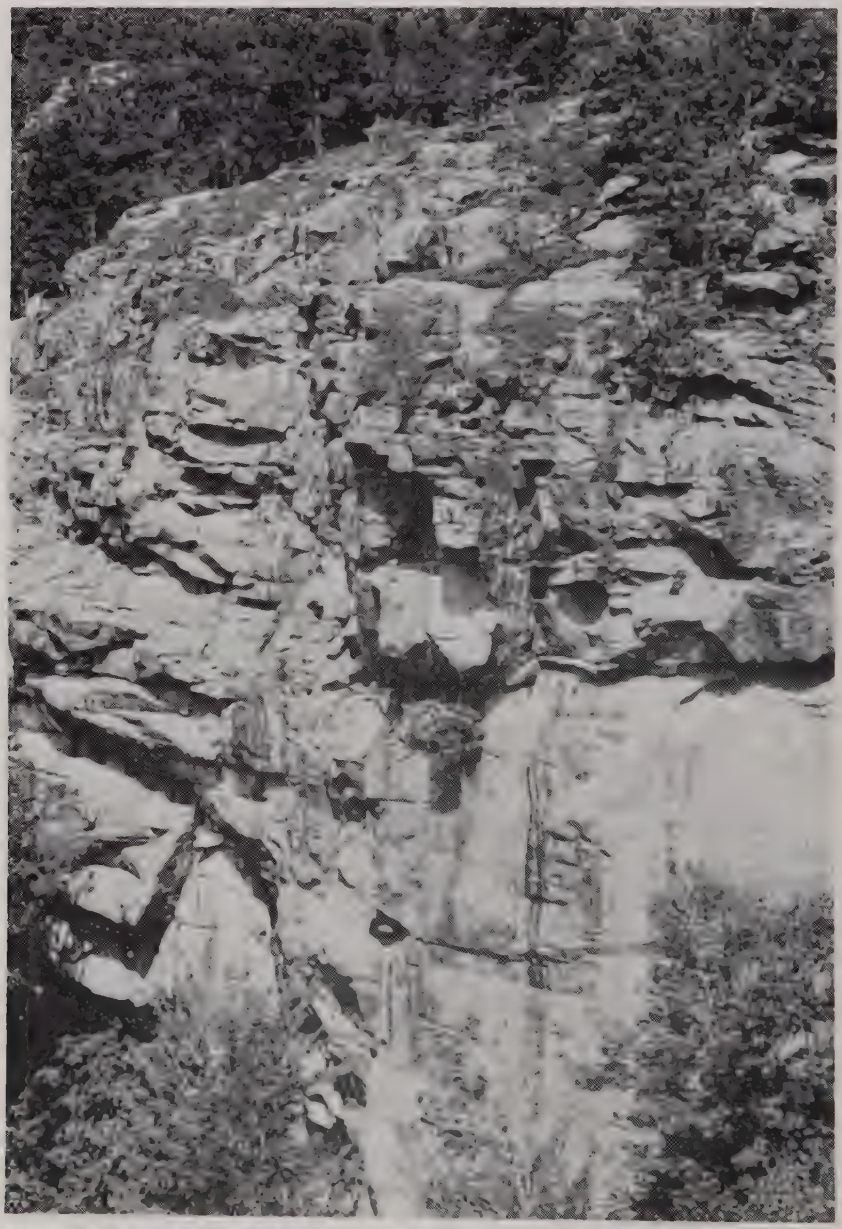
One suspected cause of decline in the golden eagle is related to failure of eggs to hatch. This was associated with two of the three nesting failures observed during this survey. The decline in breeding success (1963-1965)

Nest of golden eagle on a cliff in the Adirondacks. (July 27, 1971)

of golden eagles in Scotland (Lockie et al., 1969) was characterized by egg breakage, failure of eggs to hatch and addled eggs, the incidence of which was significantly correlated with dieldrin levels.

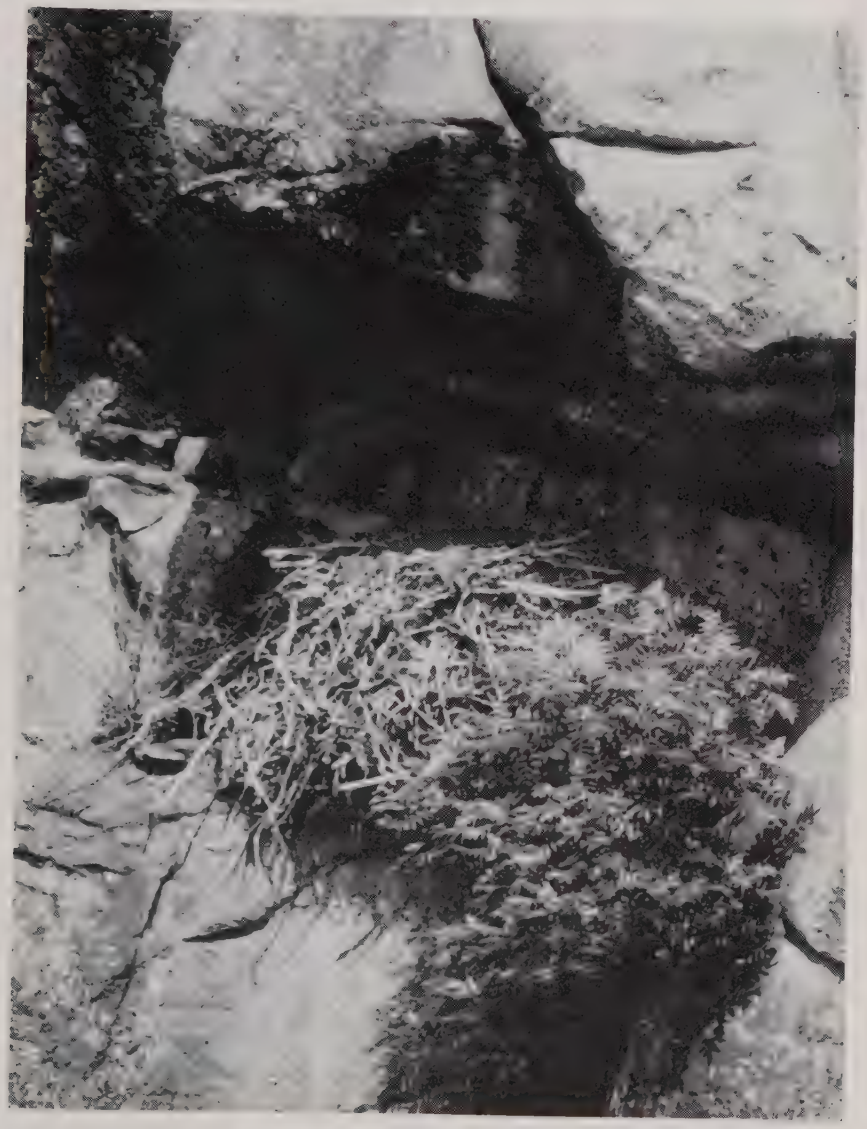
Another suspected cause of decline is linked to a reduction in the amount of suitable habitat in the Adirondack region. The habitat most used by golden eagles comprises areas suitable for their hunting tactics, i.e., burns, marshes, bogs, hillside meadows and bald knobs, railroad rights of way, woodsroads and clearings. Except for five instances where birds were found feeding on carrion on the ice of frozen ponds or lakes, all of the observations reported to the author of hunting or feeding golden eagles were associated with these types of habitat.

The increasingly efficient fire protection in the Adirondacks since 1920 has almost eliminated fire as an ecological force there. The peak of widespread fires occurred between 1903 and 1919 (Severinghaus and Brown, 1956). In certain eagle territories this is not critical. For example, the area surrounding one of the nests recorded had no known history of a major fire after 1880, but it did include rather extensive bogs and river marshes. Near two other nests, however, one observed by Greenleaf Chase in 1952 and one observed during the present survey, the amount of land burned (in 1903 and 1908, respectively) was quite extensive.



Cliff nest of golden eagle decorated by single bird in 1970 and 1971, general view of location. (photo in 1972)

Most of these burns have now reverted to forest, and this may have contributed to the disappearance of the eagles. In the former area an absence of breeding attempts was noted in the years before the pair disappeared,



Golden eagle nest at site shown on facing page. (photo in 1972)

and it may be that a lack of available food affected their breeding, either by altering the physical condition of the birds or some important component of courtship behavior. Brown (1969) postulated that a food shortage during the early egg-laying period may make it impossible for a female golden eagle to lay eggs.

Whitfield et al. (1969), reporting on a population of golden eagles in the forested section of central Saskatchewan, found that snowshoe

hares were their major summer prey and felt that the eagle population was limited by a lack of both the occurrence of fires and suitable nesting sites. The observations of this study suggest that in the Adirondacks the golden eagle popultaion may also be limited by a lack of fires. Nine of the 13 known birds present in 1970 were occupying territories that included extensive burned lands, while the remaining two pairs were using areas where, although there were few recent burns, marshes and bogs were extensive.

Determination of the cause for decline in the golden eagle in the Adirondacks, should it be chemical poisoning, food shortage or some other factor, would require further intensive studies, and in view of the present population status this may not be feasible or desirable. However, designation of certain nest sites of this species, as well as the osprey, as unique ecological areas might be considered.

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STREAM BED STABILIZATION IN ENFIELD CREEK, NEW YORK [1]

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ABSTRACT

This study was undertaken to observe the performance of bed sills in stabilizing a high-gradient trout stream subjected to severe headcutting. Gabion structures were installed in Enfield Creek (N.Y.) in 1967. A topographical survey of the stream bed was made prior to installation and in 1968, 1970, 1971 and 1973. The sills were immediately effective in arresting headcutting and in accumulating gravel material, and they had a distinct stabilizing effect for almost 0.8 mile downstream. Gabion construction is discussed, and a theory for partial failure of the two lower sills during the June 1972 flood is postulated.

The concept of a stream cycle has commanded the thinking in river hydraulics ever since its postulation by Davis (1909) more than 70 years ago. Spin-off truths and trends have grudgingly yielded to the insistent researcher, although their subleties are often lost to the layman befuddled by formulas and log graphs. Everyone who has spent any time at all on a favorite river bank, watching and dreaming, is cognizant of the erosion process, the tenuous stability and the constant flux of the stream before him.

Streams are forever shifting and changing, successively passing through geologic stages sometimes characterized as youth, maturity and old age (Morisawa, 1968). Channels tend to cut headward, decreasing their slopes as the eroded material is deposited downstream. This is the essence of the aging process. The process, of course, may be accelerated by watershed practices which produce increased runoff and sediment. Optimum trout habitat, in terms of stream aging, generally occurs between mid-youth and mid-maturity. A youthful stream is characterized by an irregular slope, falls and rapids, a V-shaped valley and a bedload which is small in amount but large in particle size. A mature stream has a comparatively smooth, reduced gradient representing deposits upon which it will begin to meander. The bed of a typical trout stream is neither bedrock nor silt, but predominantly gravels which support insect life and afford spawning sites. However well-suited to accommodate trout, such gravel beds are

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[1] This project was conceived and implemented by Maurice B. Otis, former supervisor of the Lake and Stream Improvement Section of the New York State Department of Environmental Conservation. His advice and support in preparing this paper are appreciated. Thanks are also extended to Dr. Dwight A. Webster of Cornell University for providing biological observations and to the Finger Lakes State Park Commission for its cooperation through the years.

subject to forces which displace the material, thereby disrupting the stream ecology.

New York State has long recognized the importance and frailties of its trout streams and the resource they support. An attempt to intercept the aging process—to retard degrading by stabilizing the stream bed—was the logical result of this concern and was given considerable attention in a paper on stream geometry and installations by Apmann and Otis (1965). In the study reported here, experimental bed sills were constructed to this end by the Department's Lake and Stream Improvement Section.

DESCRIPTION OF AREA

Cayuga Lake, in the Finger Lakes region of central New York, lies in the Oswego River basin and ultimately drains into Lake Ontario. At the headwaters of this basin, in the vicinity of Ithaca, the land rises in steep hills. The underlying rock formations, belonging to the Ithaca and Chemung groups, are chiefly slates and shales which are easily acted upon by water (Von Engeln, 1961). Since almost every stream flows down a precipitous hillside, the result has been the formation of deep ravines with numerous cascades and waterfalls. The 215-foot-high Taughannock Falls –50 feet higher than Niagara Falls –is only one of a dozen celebrated waterfalls in the area.

Cayuga Inlet, at the southern end of the lake, is one of the largest and most important stream systems with respect to the lake's rainbow trout

Figure 1. Portion of Ithaca West quadrangle (U.S. Geol. Sur.) showing Robert H. Treman State Park and Enfield Creek.

fishery. In addition to providing spawning and nursery grounds for lake-run rainbows, the Inlet and some of its tributaries also support a resident rainbow trout population. One of the Inlet's principal tributaries is Enfield Creek. This stream flows through the Robert H. Treman State Park about 3½ miles southwest of Ithaca (Figure 1). It is 8.8 miles long with an average drop of 89 feet per mile and a drainage area of 18 square miles. Several falls mark its course so that only the lower 0.8 mile is accessible to trout. The stream in this lower section ranges from 20 to 35 feet in width during the summer. Pools are infrequent and there is little cover except that afforded in pool depth. The average annual discharge is 7 to 9 cubic feet per second. Peak discharges of up to 150 cubic feet per second normally occur throughout March, April and May. Summer and fall discharges are generally good, but they have been known to run as low as 0.9 cubic foot per second (United States Department of the Interior, 1965-1971).

The upper portion of Enfield Creek is predominately shale and exhibits the youthful characteristics of high gradient, intermittent falls and cascades, and steep-walled, narrow gorges. A falls and fordway mark the beginning of the lower section accessible to trout (Figure 2). Prior to the 1935 flood, the stream bed below the present falls was approximately level with the fordway. Severe headcutting in the intervening years formed the existing 10-foot-high falls and the ravine below it. By 1967,

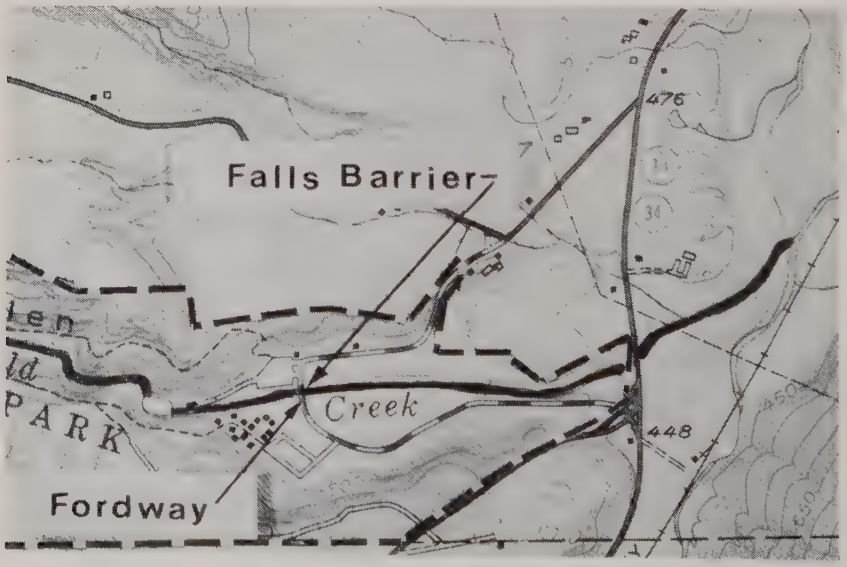

Figure 2. Section of Enfield Creek in which bed sills were constructed. Map shows, right to left: confluence of Enfield Creek and Cayuga Inlet; highway bridge; falls barrier marking upstream limit of trout migration; fordway; and upstream pool below high waterfall.

The falls barrier, fordway and upstream pedestrian catwalk as they appeared in 1968.

prior to the bed-sill installation, the bottom material from the falls to a point just above the highway bridge, a distance of almost half a mile, consisted of large stones and rubble, unstable smaller material and shallow underlying bedrock. In appearance this half-mile section was a transition zone between the solid-rock falls and a flatter downstream bed of loose glacial and alluvial deposits.

METHODS

The section selected for stabilization was an area of headcutting from the falls to about 615 feet downstream. The bed cross-section was generally flat with an over-all capacity for a 50- to 60-foot-wide channel at high water. Wooded, steep banks rose 15 to 20 feet, confining the stream in a relatively straight course to the highway bridge.

In the late fall of 1967, four stone-filled gabion bed sills were installed in this section (Figure 3). The original local gradient was 0.5 per cent. The bed sills were placed to create a new gradient of 1 per cent which would produce a velocity of 1 foot per second in normal flows. The first gabion was located 300 feet from the falls, and the remaining three were placed at intervals of 114, 96 and 96 feet, respectively.

Gabions are essentially wire baskets filled with stone. The ones used were the product of International Maccaferri Gabions of America, Inc. Each transverse sill consisted of a number of these gabions, wired together and forming upstream and downstream footings placed in the

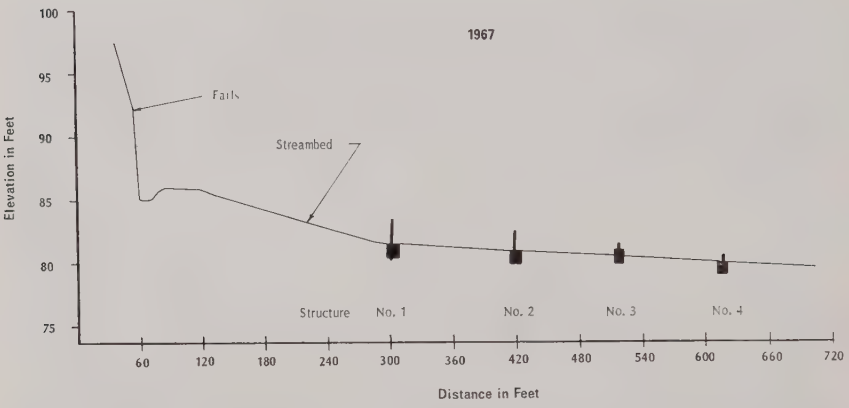

Figure 3. Profile of bed-sill section of Enfield Creek in 1967 immediately after sills were installed.

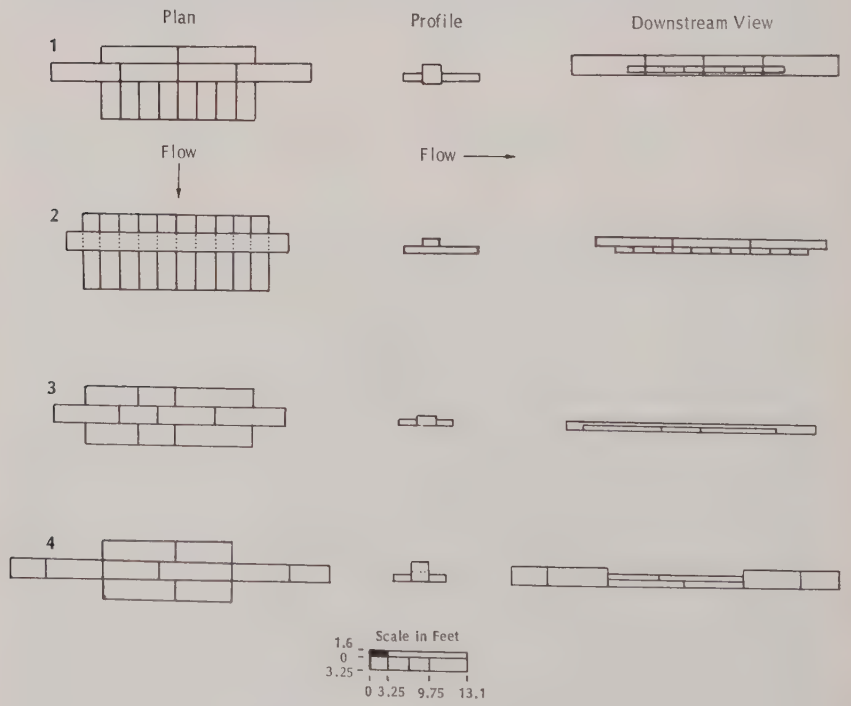

Figure 4. Gabion bed-sill designs used on Enfield Creek.

excavated stream bed to a depth flush with the bed, and a superstructure resting either on the footings or directly on the stream bed, depending on

the structure design (Figure 4). Profile dimensions of all sills were the same, except for Sills 1 and 2 where the length of the downstream footing was elongated to 6.5 feet to form a spillway. Each sill was constructed with different gabion combinations. The most elaborate structure was Sill 4 which was notched to concentrate flows to the center of the structure. All sills were built into the stream banks.

A topographical survey was conducted early in 1967 to aid in sill design and placement. Subsequent surveys were made in 1968, 1970, 1971 and 1973 to document local and downstream changes.

RESULTS AND DISCUSSION

Installation of the sills proved effective in reducing the degree of headcutting and stabilizing the stream. Furthermore, the occurrence of a severe flood in 1972 made it possible to obtain data on the long-range functioning of such structures that otherwise would have required many years of observation.

Topographical Changes in the Study Section

By 1968, the first year after the bed sills were installed, deposition had occurred primarily above the first and second structures (Figure 5). More than 89 percent of the stream bed area above Sill 1, which was originally lower than the 83.5-foot elevation of the top of the sill, had risen to the sill level. Approximately 40 per cent of the bed area above Sill 2 had reached its designed level. Minor degrading below Sill 4 continued downstream and was not attributable to the structure. Scouring occured below Sill 1, forming a pool along the length of the sill. There was no defined channel within the stream bed, the difference in thalweg and adjacent stream bed elevations being minor.

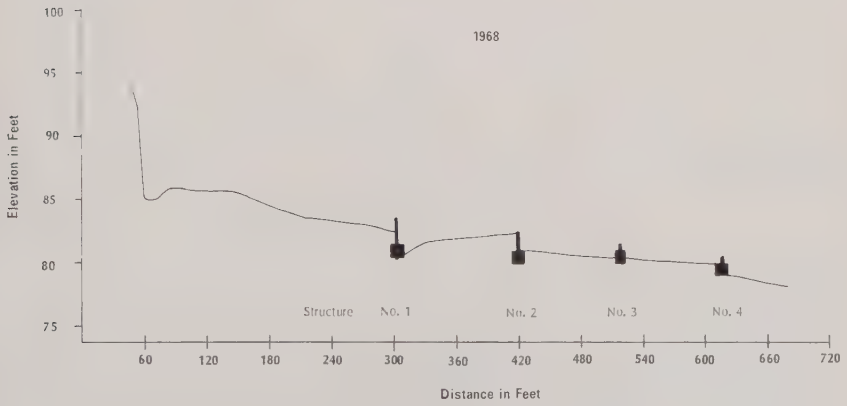

Figure 5. Profile of bed-sill section of Enfield Creek in 1968

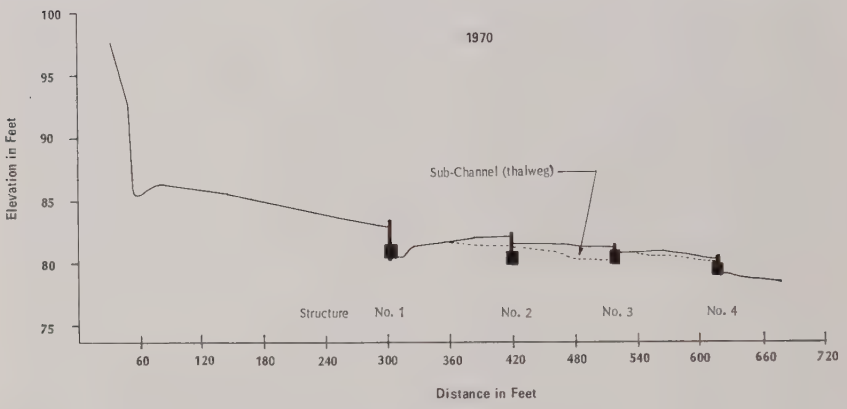

Figure 6. Profile of bed-sill section of Enfield Creek in 1970.

Table 1. Summary of Periods of High Discharge (peaks exceeding 40 cubic feet per second) in Enfield Creek *

Interval	Year	Range of discharge §	Duration (days)	Average high-water discharge per interval §
Prior to 1967 survey	1965	20– 56	7	
	1966	29– 59	5	60
		23– 76	7	
		52	1	
Between 1967 and 1968 surveys	1967–1968	29– 63	8	
		29– 92	3	
		29– 52	2	67
		26– 50	5	
		20– 78	9	
Between 1968 and 1970 surveys	1968	27– 49	4	
		21– 42	4	
		31– 49	2	
		40– 45	2	
				64
	1969	42– 45	2	
		27– 80	5	
	1970	25–125	26	
		72– 78	2	
Between 1970 and 1971 surveys	1970–1971	28– 54	2	
		29– 90	5	
		27– 95	5	82
		27–150	7	
		27– 54	7	
		27– 52	3	
Between 1971 and 1973 surveys	†	3,700 (est.)	..	..

*Estimated from flow data for Cayuga Inlet for the years indicated (United States Department of the Interior, 1965–1971).
§ Cubic feet per second.
† No published data available.

The series of gabion bed sills in the fall of 1970, looking upstream from Sill 4.

The 1970 survey showed the first sill backing up a near-maximum capacity and the other sills successfully retaining bottom material (Figure 6). A well-defined sub-channel or low-flow channel, represented by the thalweg, was present in the left side of the stream bed.

The average high-water discharge between the 1970 and 1971 surveys was higher than that at any other interval in the study, reaching a peak of 150 cubic feet per second (Table 1). Rubble deposition from the falls in 1971 produced a local gradient increase which degraded some of the bed above Sill 1 (Figure 7). The Sill 1 pool became more exaggerated

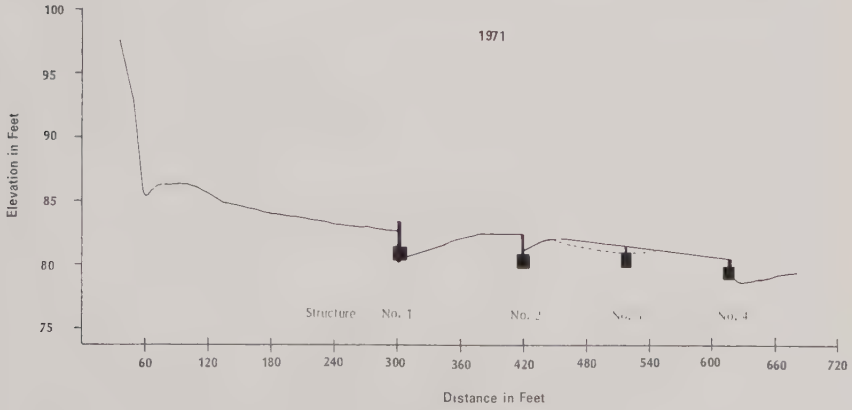

Figure 7. Profile of bed-sill section of Enfield Creek in 1971.

and a small pool was cut below Sill 2. The backed-up levels for Sills 3 and 4 remained relatively stable, and the thalweg became more shallow. The drop from Sill 4 slightly increased due to the increased water velocities produced by the steepening of the upstream slope.

The 1972 Flood

The frequency of floods such as that produced by Hurricane Agnes in June of 1972 has been estimated at 200 to 250 years. Discharge estimates for Enfield Creek were in the order of 3,700 cubic feet per second (Hood, personal communication)[2]. This flooding in the Enfield drainage, however, was of lesser magnitude than the July 1935 flood of 8,400 cubic feet per second which initiated formation of the present falls and ravine.

A steel sheet-pile retaining wall with a concrete cap had been constructed by Park officials along the face of the rock falls in late 1971 to prevent further erosion and to protect the fordway. This action prevented a considerable amount of shale from contributing to the flood bedload.

Gabion bed sill series following 1972 flood. A portion of Sill 3 (foreground) has failed, fine streambed gravel has washed out exposing cobbles and boulders, and a deep channel has formed in the left side of the streambed. Sills 2 and 1 are seen in the background.

Compared with the 1971 survey, the 1973 survey showed only slight scour of the back-up material of Sill 1, and complete filling and leveling

[2] James W. Hood, Jr., U.S. Geological Survey, Ithaca, N.Y.

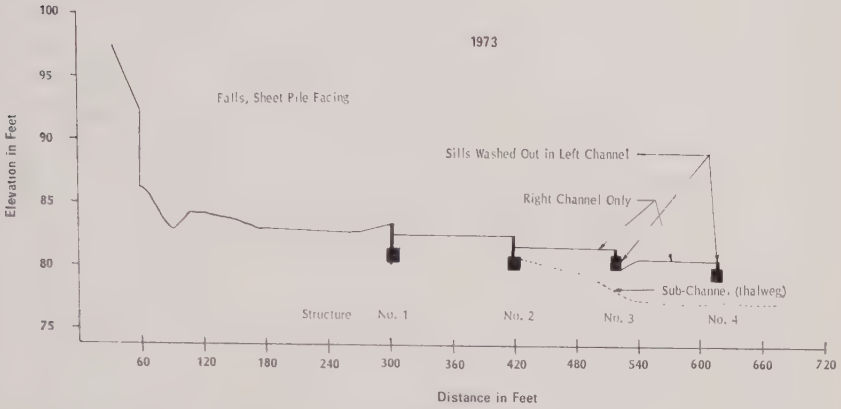

Figure 8. Profile of bed-sill section of Enfield Creek in 1973.

behind Sill 2 (Figure 8). Sections of gabion in Sills 3 and 4, from the midline of the structure to the left bank, washed away leaving barely a trace. The unobstructed flow severely scoured the left side of the channel upstream to Sill 2. End-cutting also occurred at the right abutments of these two structures. Gabion sections that remained, however, continued to hold the material previously deposited.

Local Effectiveness of Bed Sills

The bed sills were immediately effective in building up the stream bed and continued to cause aggrading throughout the survey years. Minor degrading which occurred in the sill area can be attributed to annual variations in quantity of bed load, magnitude and frequency of high discharges, and local turbulence and eddying caused by exposed sills.

Only on one occasion was the designed slope achieved between sills, i.e., between Sills 3 and 4 in 1971 (Figure 7). The continual hydraulicking below the bed sill (particularly the first sill where the upstream gradient is consistently the steepest), the exposing action of ice scour, and eddying near the upstream edge of the rectangular sill create difficult conditions in which to maintain a design slope. The nearly horizontal slopes observed in 1973 (Figure 8), with uniform drops from sill to sill, probably represent the best performance that can be expected when this design of gabion is used.

Downstream Effect of Bed Sills

The downstream survey made in 1967 prior to bed-sill installation showed the stream from just below Sill 4 to the mouth to be highly irregular (Figure 9). Pronounced headcutting appeared 1,200 feet below the sill and the steep gradient continued to the mouth. The average slope of this downstream section was 0.78 per cent.

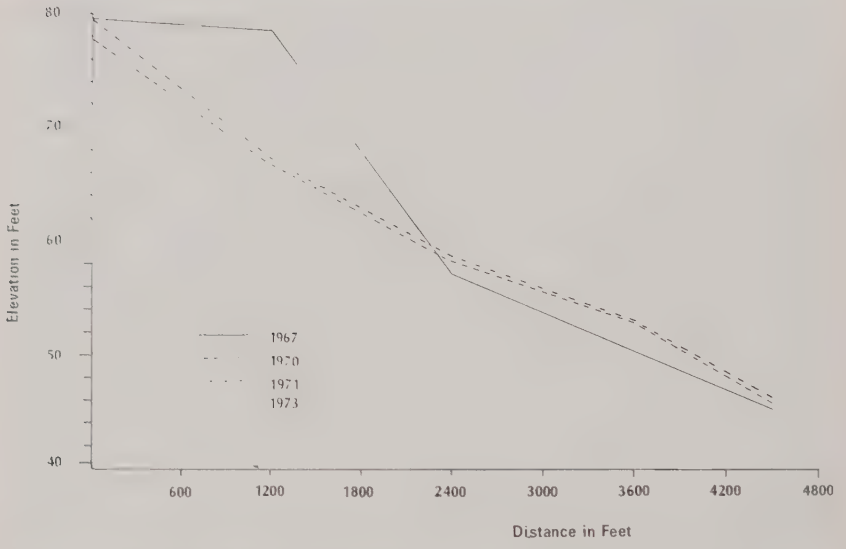

Figure 9. Profile of streambed thalweg from the face of Sill 4 to the mouth of Enfield Creek.

Following sill installation, in 1970 and 1971 a uniform, concave profile was plotted throughout the section. The slight aggrading below Sill 4 in 1971 changed the average slope between these years from 0.67 to 0.68 per cent. It is worth noting again that the average discharge was of greater magnitude between 1970 and 1971 than at any time in the three years between the 1967 and 1970 surveys. Hettner, according to Morisawa (1968), has stated that the profile established by a stream is a function of high-water or flood discharge. Smooth profiles have been interpreted as a state of equilibrium in which the stream has just that slope which provides the competency and capacity to transport its load. Such graded streams can maintain this stability only through small, gradual changes in slope (Morisawa, 1968, pp. 120-123).This phenomenon is usually achieved in large rivers over a period of years. Its observance in Enfield Creek is attributed to bedload reduction by the sills.

The flood in June of 1972 exaggerated the tendency of this stream to headcut but had no direct effect on the stabilized bed-sill area. Material carried in the flood aggraded further downstream to produce the flattest slope recorded, i.e., 0.60 per cent.

The Structures

The manufacturer of the gabion baskets characterizes them as "flexible, permeable, stable, and economical". Minor settling and adjustment of the sills to the streambed contours, noted as irregularities in elevation along the top of the superstructure, were noticeable after the first year,

but did not appear to affect bed-sill operation. While the structures are initially permeable and able to absorb high water pressure, they eventually fill with smaller rocks and sediment. It has been suggested (Otis, personal communication)[3] that this characteristic was responsible for the failure of the left halves of the two lower sills in the flood. Compaction of this smaller material within the gabion effectively made it a rigid, resisting structure. Sill 4 had no counter pressure against it in the form of downstream bed material. If the sub-channel behind this structure in the left part of the channel in 1970 and again in 1971 existed prior to the flood, its flow could have concentrated pressure on the upstream side of the exposed and impermeable left gabions. Following the failure of Sill 4, cutting continued up the left channel to Sill 3 where the same process was repeated.

This theory of structural failure is supported by signs of stress on the remaining portions of gabion. The basket mesh is constructed of zinc-coated steel wire of metric gauge 17 (0.1181 inch) joined in a hexogonal pattern by a triple twist of the wire. Breaks in the wire occurred on the tops and faces of the superstructure and on the downstream footings. Breaks were associated with pronounced distortion of the hexagon. Broken wires, drawn out and tapered, can only result from tremendous stress.

As a point of comparison with the kind of pressures that were encountered during the flood, the manufacturer at one time conducted a gabion rupture test by applying a steel ram head operated by a hydraulic pump to one of its baskets. Ultimate failure occurred at 6,555 pounds per square foot.

Barring another record flood, restored portions of Sills 3 and 4 can be expected to remain intact indefinitely. The bed sills in Enfield Creek have required no other maintenance or replacement (as of 1973).

An improvement in design of the gabion for bed-sill use might be to eliminate the angular seam and flat top responsible for adjacent upstream eddying and downstream scour. A generously-cut top or lower basket sides would permit stones to be be laid in a relatively smooth arch allowing water to flow over the gabion with the least resistance and velocity change. Under such conditions the slope of the stream bed could more nearly approach the design slope. The desired slope might also be approached by spacing the bed sills closer together, but the effective stabilized area would be less.

While it is desirable from a fisheries standpoint to maintain a summer low-flow channel, indications that a sub-channel upstream from Sill 4 contributed to the loss of this sill during the flood suggest the potential hazard of fostering a sub-channel particularly when it is allowed to wander toward the abutments. Since the sills have sustained no damage

[3]Maurice B. Otis, New York State Department of Environmental Conservation

in normally high flows, a low-flow channel compatible with structure design could be encouraged by slightly depressing the centerline elevation of the reconstructed sills. Concentration would increase depths and decrease the warming of the water, and grade gravel material. Low-channel maintenance may be academic in Enfield Creek, as an exposed pool below the falls upstream from the fordway (Figure 2) often warms the water to the extent that young-of-the-year rainbow trout must migrate downstream (Webster, personal communication)[4].

Installation of a longer apron on Sill 4 might lessen the possibility of undermining by the overfall and arrest the effects of headcutting on the bed sill. Measures are needed to stabilize the sliding left bank, particularly in the abutment area.

Gravel and the Fishery

A by-product of stream-bed stabilization by using bed sills is the accumulation of gravel material. Suitable spawning gravel (about 1½ inch in diameter) exposed by the stilling action of the falls upstream from the fordway was expected to fall out between the sills. Large material was also deposited, however, as might be expected in a young stream of high gradient, thus reducing the potential spawning area. Fisheries inventories were made sporadically, usually during the summer, by graduate students in the Department of Natural Resources at Cornell University. In the

Table 2. Cost of Installing Four Gabion Sills*

Item	Cost
Temporary labor	
455 man hours @ $2.25	$1,023.75
Materials	
Stone§	870.00
Gabions (55 pieces of various sizes)	797.51
Rental of rubber-tired backhoe and loader	
219 hours @ $10.50	2,299.50
Total	4,990.76
Cost per cubic yard in place†	55.44

*Represents work done in 1967.
§Cost of stone reflects total quantity used, including abutments and necessary bank protection.
†Based on volume of baskets used, i.e., 90.02 cubic yards.

bed-sill section no rainbows of any age group were taken in 1967, but both 0+ and I+ trout were collected in years after the sills were installed. Redds were observed in the sill area in the spring where large

[4]Dr. Dwight A. Webster, professor of fisheries science, Cornell University.

TABLE 3. POTENTIAL COST BENEFIT, WITH RESPECT TO RAINBOW TROUT FISHERY, FROM BED-SILL INSTALLATION

Item	Possible maximum
Gravel accumulation	800*
Number of redds	400
Total number of eggs from 400 female trout§	1,200,000
Number of fry hatched (70 per cent)	840,000
Number of surviving fall fingerlings (30 per cent)	252,000
Number of surviving out-migrants (30 per cent)	75,600
Number returning as adults (10 per cent)	7,560
Total value of fishery (at $5.00 per fish)	$37,800
Total cost of installation	5,000
Cost-benefit ratio	1:7

*Square yards.
§Assumed to be 6-pound fish.

stones and bedrock formerly afforded no spawning sites. Furthermore, in the summer of 1969 an average of 22 age 0+ rainbow trout per 100 feet were collected in lower Enfield Creek. This was the highest density of parr sampled in the stream. It is postulated that the stabilizing effect of the bed sills, both locally and downstream, substantially contributed to these unprecedented observations.

The cost of the four installations was just under $5,000, or $55 per cubic yard in place (Table 2). A maximum cost-benefit ratio, based on rainbow trout produced and assuming ideal gravel conditions, has been fixed at 1:7 (Table 3). Even half this estimate is a substantial return from one year's spawning. Equally important intangible benefits are bed stabilization, arrest of future degrading, improvement of stream aesthetics, extension of fish habitat and the preservation of a portion of the stream that is of direct recreational value.

CONCLUSIONS

The bed sills installed in Enfield Creek effectively stabilized the stream bed, and their gabion construction proved durable even in severe flooding. It is anticipated that eventually another series of bed sills will have to be constructed downstream, depending on the degree and rate of future degrading. There are still many questions to be answered concerning where such a series might be placed in relation to a given stream geometry, what constitutes ideal sill spacing, what slopes can be expected and what their relationships might be to the adjacent, natural stream bed.

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CARRYING CAPACITY OF THE DEER RANGE IN THE TOWN OF MALONE[1]

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New York State Department of
Environmental Conservation

ABSTRACT

Cover mapping of the Town of Malone was undertaken to determine the capability of the town to support greater numbers of deer. Acreages are given for the four major cover classes and their subdivisions. The current year-around deer habitat was calculated to be 45,962 acres. Winter habitat for deer was calculated to range from a minimum of 4,481 to a maximum of 15,978 acres. Application of both these concepts of winter habitat to the carrying capacity for deer in the town is discussed. A total winter deer population of 140 animals is suggested.

The Town of Malone in Franklin County is representative of the peripheral Adirondack area where deer populations have been extremely low for many years. In evaluating the factors limiting deer abundance in the Adirondack region, Severinghaus and Free (1963) found that in this peripheral area the population was well below the carrying capacity of the range. They concluded that "Substantial increases are possible if losses among does can be substantially reduced".

In 1968, an investigation of this possibility was begun using the Town of Malone as the study area. The ultimate objective was to increase the deer population in the town. It was recognized, however, that the number of deer should not exceed the carrying capacity of the range. Therefore, one phase of the study was to assess that carrying capacity, particularly with respect to winter which is the critical season in northern New York. To do this, a cover-type survey of the town was made in terms of deer food and shelter.

There has been very little work done, and there are no documented studies, on the vegetative types, other than marshes, of the peripheral Adirondacks. Thus little is known about winter food and shelter conditions for deer. In the present study, the entire Town of Malone (except developed areas and water) was considered potential deer habitat. Throughout the study period to date (1972) deer have wintered in the town. In the northern half, however, they did not spend the entire period except during the mild winter of 1971-72. Aerial and ground surveys by Department personnel revealed deer spending entire winters in concentrations both north and south of the town. There were two notable concentration areas to the north, one in the Town of Fort Covington and

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[1] A contribution of Federal Aid in Fish and Wildlife Restoration Project W-89-R.

Figure 1. Map of Town of Malone showing distribution of major cover types.

the other in the Town of Clinton near Churubusco. Many wintering concentrations occurred south of the town (Jackson, 1971) one of which (Deer River Flow) was observed closely during the study. During other seasons deer were seen over the entire town; however, prior to the study and during its first two years, deer were rare north of Route 11 (Figure 1).

Topography, vegetative cover and land use are in sharp contrast between the northern and southern portions of the town. The northern half lies in the St. Lawrence valley. Soils there are primarily sandy (characterized by Adams and Wallace loamy sand) since the area was an outwash plain of a prehistoric lake (Anonymous, 1952), particularly the Barre Hill area which was a river delta at that time. This half is essentially flat and is now heavily cultivated or pastured, except for Barre Hill. Soils become stony as one progresses southward. The Titusville Mountains are characterized by Becket and Herman soils which are typical of the central Adirondacks. These soils are productive when heavily limed but are difficult to till due to their stony nature and the rough terrain. The southern half of the town is largely covered with a northern hardwood forest. The diversity of soil types, terrain and land use, and their associated microclimates, form a variety of habitats with different potentials for supporting deer.

METHODS

The carrying capacity of the deer range in the Town of Malone was assessed by determining the extent and types of overstory and understory vegetation present. Five steps were involved: (1) a preliminary field reconnaissance; (2) cover typing and field write-up; (3) preparing a cover-type mosaic map from aerial photos; (4) tabulating cover acreages; and (5) determining the potential winter habitat for deer.

FIELD RECONNAISSANCE

Polyester-base aerial photos (9½ x 9½ inches) were purchased from

Aerial Photo(s)No. _____ No. _____
Species: _____ Type:
Rep:E A Density: N L M F Shelter: 1 2 3 4 5
SU: Den: L M H Ht: L M H Species: _____
HU: Den: L M H Ht: L M H Species: _____
Slope: 0 1 2 3 4 Aspect: N E S W O
Remarks: _____
_____
_____

Figure 2. Field data form used for recording cover-type information.

the U.S. Department of Agriculture, 66 being needed to provide stereo coverage of the town. These photos were used to locate representative cover types which would serve as the basis for devising a field data sheet suitable to the needs of the study. The cover-type designations and species symbols used followed those developed earlier for wildlife studies by Department personnel (Anonymous, 1944). The field data form (Figure 2), used for all cover write-ups, was derived by applying this cover system in areas selected from the photos and by making adjustments in recoding procedures to fit cover situations of the peripheral Adirondack area (Jackson, 1970).

Cover Typing

Field work was done by a specially trained technician during the summers of 1969 and 1970. The technician worked with the conservation biologist, who developed the field form, before proceeding on his own.

All aerial photos were covered with acetate overlay, and a pocket stereoscope was used to help outline the various types on each overlay. These outlines were made before going into the field. Each cover type was then verified in the field, and a field data form was completed after walking through a representative portion of the type. Whenever a cover type was considered to be different from one previously recorded, a new form was completed. Where there was no obvious difference, the cover type and write-up number of a previous, similar type was used. The cover-type designation and write-up number (e.g., 3A-15) were written on each cover-type unit on each overlay for later reference when preparing the cover mosaic.

Four major cover classifications were used (Jackson, 1970).

1. Open land
2. Overgrown land
3. Woodland
4. Slashing

Subclassifications of open land, as well as slashings, were identified solely from the aerial photos and written on each overlay. Field write-ups were made only for overgrown land and woodland. The system of classification described by Anonymous (1944) was used, except that the designations for woodland types were changed slightly. Because overgrown land and woodland are the primary components of deer range, the subclassifications used for them are given.

2. Overgrown land*
   - A Deciduous trees and shrubs—80 per cent or more of total cover
     - As Chiefly shrubs
     - At Chiefly temporary tree species
     - Ap Chiefly permanent tree species

B Coniferous trees and shrubs—chiefly old fields seeded in or planted to conifers

C Mixtures of deciduous and coniferous trees and/or shrubs

Cs Conifers and shrubs

Ct Conifers and temporary tree species

Cp Conifers and permanent tree species

* (ws) added to any designation represented a brushy or wooded swamp.

3. Woodland

A Hardwood—over 80 per cent of total crown area comprised of hardwood species

B Softwood—over 80 per cent of total crown area comprised of softwood species

AB Hardwood-softwood—mixed growth with 51 to 80 per cent of total crown area comprised of hardwood species

BA Softwood-hardwood—mixed growth with 51 to 80 per cent of total crown area comprised of softwood species

Cover-type designations as used in recording the data were: 2As, 2B, 2Ct, 3AB, etc.

Age representation, crown density, overstory shelter, softwood understory, hardwood understory, slope and aspect were all recorded in the field write-ups according to the system described by Anonymous (1944).

A remarks section on the data form was used for comments on land use such as logging or planting, change in stand composition as a result of beaver or snowshoe hare activity, and general observations such as "uniform mature sugar maple stand" or "characteristic close-grown Scotch pine stand", etc.

Cover-type Mosaic

On completion of the cover survey, the acetate overlays were pieced together and taped down on a light table. Due to parallax and distortion at the edges of the aerial photos, some adjustment of cover-type lines was necessary in order for all the lines to meet properly in the mosaic. For each cover type, the designation was then printed on the mosaic. This work copy was reproduced, and the major cover classifications were color coded.

Tabulating Cover Acreage

A dot-grid was used to determine the acreage of each cover type. The mosaic map was subdivided into 4 x 4-inch blocks, each identified by number on the vertical axis and by letter on the horizontal axis. Each block corresponded to a grid of 1-inch squares each having a pattern of

dots calibrated so that, at the scale of the aerial photos used (1 inch= 63,360 feet), each dot represented 10 acres. Tabulations were made by counting all dots in each cover type in Blocks 1A, 1B, etc. Dots from like types in all bocks were then added and multiplied by 10 to give the total acreage for each type.

Determining Potential Winter Habitat for Deer

Carrying capacity as defined by wildlife biologists (Eabry, 1970) refers to the maximum number of animals that can be sustained in a given ecosystem under the least favorable environmental conditions over a period of time. The least favorable environmental conditions for deer in the Northeast occur during the winter. Therefore, a determination of potential winter habitat for deer was paramount to determining the actual carrying capacity for the Town of Malone.

First, the total deer habitat was derived by subtracting the amount of non-deer habitat from the total acreage in the town. It might be assumed that during mild winters deer would occupy this habitat the year around. This is not the case, however. Even though their ability to travel were not restricted, food availability and shelter requirements would limit the area occupied. The presence of cover types with available browse for a maintenance diet cannot be equated directly with carrying capacity since deer may not choose to stay in these types. Regardless of whether or not softwood cover is essential for deer, where this type of cover exists they will seek it during the winter. Therefore, the relationship of available food to softwood shelter will ultimately determine carrying capacity under a given set of environmental conditions over a given period of time. In deriving reasonable approximations of the minimum and maximum winter deer habitat in the town, both food availability and shelter requirements were considered.

RESULTS

The calculated acreages for the various cover types (Table 1) were used to determine the amount of total deer habitat in the Town of Malone and the amount of potential wintering habitat. The total area of the town is 66,752 acres. When the acreages of cultivated areas (1A), open water, marsh and bogs (1D), developed areas (1E) and other open areas (1F) are subtracted, the remaining 45,962 acres represent the total deer habitat at the time of survey. This was 2.3 per cent less than that of 47,031 acres as given for 1958 by Severinghaus and Sauer (1964). Recent reports by the Franklin County Chamber of Commerce indicate no major land development during the 10-year interval, so the difference is not considered significant. Deer habitat constituted nearly 69 per cent of the total area of the town.

TABLE 1. CALCULATED ACREAGE FOR THE VARIOUS COVER TYPES IN THE TOWN OF MALONE

Designation	Description	Acreage
	Open land	
1A	Cultivated areas	13,678
1B	Old fields	3,072
1C	Pastured areas	5,637
1D	Open water, marsh and bogs	1,144
1E	Developed areas	5,540
1F	Other open areas	428
Sub-total		29,499
	Overgrown land	
2As	Chiefly shrubs	30
2At	Temporary tree species	5,926
2At(ws)	Temporary tree species (swamp)	1,524
2Ap	Permanent tree species	303
2Cs	Mixed conifers and shrubs	45
2Ct	Mixed conifers and temporary tree species	1,424
2Ct(ws)	Mixed conifers and temporary tree species (swamp)	98
2Cp	Mixed conifers and permanent tree species	0
2Cp(ws)	Mixed conifers and permanent tree species (swamp)	314
2At-Ap	Mixed temporary and permanent tree species	323
Sub-total		9,987
	Woodland	
3A	Hardwoods	20,700
3AB	Mixed, 51 to 80 per cent hardwoods	2,023
3BA	Mixed, 51 to 80 per cent softwoods	1,511
3B	Softwoods	2,970
Sub-total		27,204
	Slashing*	
4As	Sprout stage dominant	62
Sub-total		62
Total		66,752

*Including recently cleared land.

Winters when snow depths exceed 20 inches through most of the period are considered severe and represent the minimum winter range situation. Under these conditions, deer are essentially restricted to major softwood cover (types 3B and 3BA). During the study, deer sought such cover when the snow became deep and thereafter did not travel extensively elsewhere because of the snow depth. The minimum winter deer habitat, i.e., that which can be expected to hold deer during severe winters, was considered to be the combined area of these types or 4,481 acres. The areas of type 3AB in the town contained up to 50 per cent softwood and had been known to hold a few deer in some winters. However, all but one of those surveyed had overstory shelter ratings of 1 or 2

(shelter scarce or absent). Deer normally move from such cover to heavier softwood types in severe winters.

Even in mild winters there are short periods of cold weather and deep snow when deer will seek softwood cover. Consequently, shelter is still important during these winters. However, with little or no restriction on mobility, deer disperse over a much larger area. Food availability then determines where they will be found. Much of the town has little or no valuable woody browse for deer even in mild winters and can be excluded as winter habitat. Thus, the maximum winter habitat was derived by adding to the minimum habitat the acreage of cover types (other than 3B and 3AB) with an understory of hardwoods and white cedar under 8 feet in height and having a moderate to high density. The added area amounted to 11,497 acres (Table 2), and, when combined with

Table 2. Area of Overgrown Land and Woodland (exclusive of types 3B and 3BA) in the Town of Malone With an Understory of Hardwoods and White Cedar of Moderate to High Density and Less Than 8 Feet in Height*

Designation	Description	Acreage
2As	Chiefly shrubs	30
2At	Temporary tree species	3,676
2At(ws)	Temporary tree species (swamp)	400
2Ct	Mixed conifers and temporary tree species	816
2Ct(ws)	Mixed conifers and temporary tree species (swamp)	98
2Cp(ws)	Mixed conifers and permanent tree species (swamp)	279
2At-Ap	Mixed conifers and temporary tree species	323
3A	Hardwoods	5,112
3AB	Mixed, 51 to 80 per cent hardwoods	701
Total		11,497

*Excluding alder and willow swamps which were considered of no value for wintering deer.

the minimum habitat (4,481 acres) gave a total of 15,978 acres as the maximum winter deer habitat. This represents the area that could reasonably support deer in a mild to moderate winter.

The minimum and maximum acreages of winter habitat for deer are compared with the total area in the Town of Malone in Table 3. It is apparent that during a severe winter, when deer are restricted to soft-

Table 3. Minimum and Maximum Areas of Winter Deer Habitat and Their Relation to the Total Area of the Town of Malone

Area	Acres	Percentage of total area of town
Minimum winter habitat	4,481	6.7
Maximum winter habitat	15,978	23.9
Total area of town	66,752	100.0

TABLE 4. POPULATION LEVELS THAT MIGHT BE CARRIED IN THE TOWN OF MALONE FOR MINIMUM AND MAXIMUM AREAS OF WINTER DEER HABITAT AT DIFFERENT RATES OF STOCKING

Rate of stocking*	Population that might be carried	
	Based on minimum winter habitat of 4,481 acres (7 square miles)	Based on maximum winter habitat of 15,978 acres (25 square miles)
5§	35	125
10	70	250
15	105	375
20	140	500
25	175	625
30†	210	750

* Deer per square mile of wintering area.
§ Typical rate of stocking in peripheral Adirondacks is five deer or less per square mile.
† Rate of stocking in parts of the Southern Tier and on the Seneca Army Depot, where winter starvation is negligible.

wood cover, the carrying capacity of the deer range (for that year) is reduced to about one-third that for a winter when deer are not confined to the softwoods (15,978 vs. 4,481 acres). Since the maximum winter habitat that would be occupied during a mild winter is only 24 per cent of the total area of the town, severe winters would result in severe range deterioration and possible starvation if deer numbers were allowed to reach a carrying capacity based on mild winters.

The figures for minimum and maximum winter habitat provide a reasonable basis for discussing deer population levels for the town. Table 4 shows the deer population, for different stocking rates, that could be carried in terms of each amount of winter habitat area. These figures should not be confused with deer per square mile of year-around habitat.

The most desirable carrying capacity for deer in the Town of Malone is not known and cannot be readily calculated. It lies somewhere between the current level of about five deer per square mile of wintering area and that of 30 deer per square mile that has existed in some parts of western New York. It is not reasonable to suppose that the latter density could be maintained in the Malone area since the winters are more severe there than in western New York. A reasonable number to start with in deriving the long-term carrying capacity would be 20 deer per square mile of wintering area or 140 as the minimum population in the town. In the Adirondacks generally, antlered bucks (1½ years old or older) comprise about one-third of the total deer population. Applying this to the Town of Malone, a deer population of 140 animals would contain 47 antlered bucks. About 80 per cent of all such bucks are taken by hunters each year in the peripheral Adirondacks. Therefore, when the calculated harvest of antlered bucks reaches 38, a total deer population of 140 may be assumed to have been attained. Similarly, a reasonable

estimate of the actual deer population for any given year could be obtained by expanding the calculated take of antlered deer for that year.

DISCUSSION

Many factors complicate a determination of the winter habitat and associated carrying capacity of a given range for deer. Perhaps the greatest vagary of all is weather. The definition of carrying capacity given by Eabry (1970) takes limiting weather conditions into account. The separate calculations for minimum and maximum winter habitat in the Town of Malone are predicated on weather. If all winters were mild, three times as many deer could be successfully carried over each year.

The amount of food and the extent of softwood shelter can be determined through a cover study such as this. The proximity of food to shelter is important, but no fixed distance can be used since deer mobility may vary from 25 feet to several miles depending on travel conditions. Likewise, there is no way to assure that deer will distribute themselves "properly" on a winter range. On the contrary, deer tend to congregate during periods of winter stress.

The density, height and species-composition determinations for recording cover-type data in this study were all ocular estimates. In light of the variables discussed, and in consideration of the time and cost of obtaining more accurate data, it was felt that such estimates by a trained observer would provide sufficiently accurate information. Carrying capacity in relation to time intervals is dynamic due to changing environmental conditions and associated food availability. Deer behavior and movement patters merely complicate the situation.

CONCLUSIONS

The findings of this study show that, while determining the absolute carrying capacity of a given range for deer may not be practical or even possible, its winter deer habitat can be delineated by means of a cover-type survey. While data derived by ocular estimate are not precise, they can provide reasonably accurate information on overstory and understory cover which can be used to determine what the winter deer population should be. This is important because of the high reproductive potential of deer. Once a reasonable population level is reached, the actual numbers which should be carried overwinter can be determined more exactly from the physical indices of the deer present on the area. Harvest quotas can then be adjusted to maintain the population at the desired level.

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A PRELIMINARY PHYTOPLANKTON SURVEY OF TWELVE ADIRONDACK LAKES

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ABSTRACT

This investigation was conducted to evaluate the relationships between composition and abundance of phytoplankton in 12 lakes in the Adirondack region of New York. Possible differences in eutrophication are also considered. Five divisions and 60 taxa were catalogued. All the lakes were found to be oligotrophic and dystrophic although there was some indication of pollution. Possible effects of Hurricane Agnes in 1972 are discussed.

The Adirondack region in northern New York has hundreds of glaciated lakes; most are dystrophic and oligotrophic. The dystrophic, or brown-colored water, condition is due to organic stains seeping into lakes. The lakes are relatively free from pollution and are used mainly for recreation.

Phycologists and limnologists have studied many bodies of water, but little work has been done on brown-water lakes. The purpose of this study was to evaluate the composition and abundance of phytoplankton in 12 lakes (Figure 1) in the central Adirondacks where a coniferous forest predominates. Most of these are associated with bogs or have bogs draining into them which accounts for the dystrophic conditions observed.

All samples were taken between June 30 and July 3 in 1972, at a distance of 50 to 150 feet from shore. In most cases the collection points had cabins or campgrounds in the immediate area. The data were collected a week after Hurricane Agnes and most of the lakes were still in flood condition. Phytoplankton samplings consisted of 10 consecutive vertical tows with a #25 plankton net. The algae samples were preserved in Lugol's solution for later identification. pH and temperature were immediately taken from the collection vial, before adding Lugol's solution, using two types of indicator paper (Nitrazine and pHydrion) and a standard laboratory thermometer, respectively. A 12-inch Secchi disc was used to measure light penetration.

Identification and enumeration of the phytoplankton were done using a light microscope. Two drops of sample were taken from the collection vial and counted, 10 such slides being prepared for each collection site. The generic designations listed by Smith (1950) were used whenever possible. A variety of sources were consulted for specific identifications:

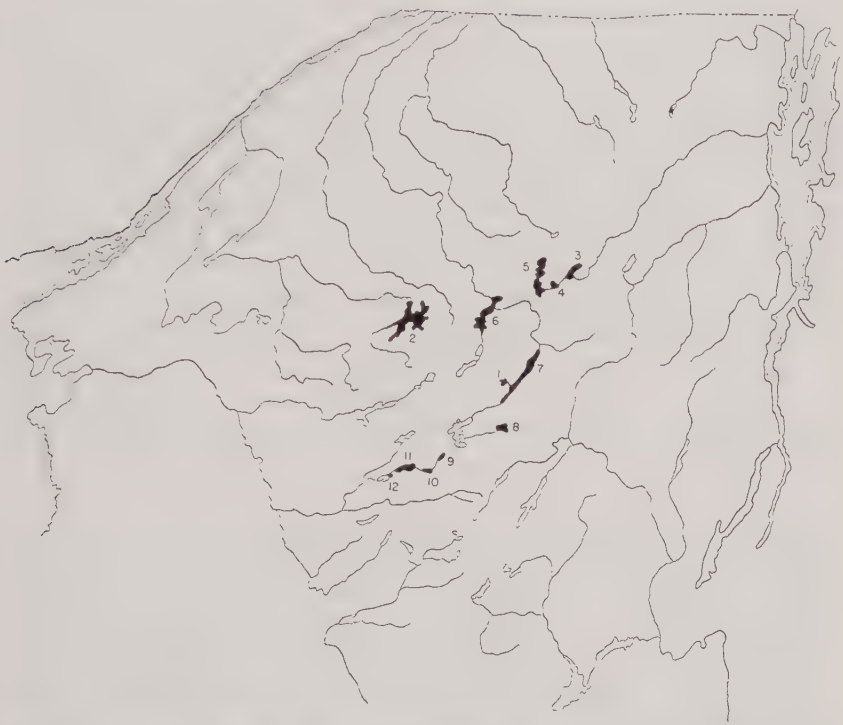

Figure 1. Map of northern New York showing location of the 12 lakes studied: (1) Eaton Lake, (2) Cranberry Lake, (3) Lower Saranac Lake, (4) Middle Saranac Lake, (5) Upper Saranac Lake, (6) Tupper Lake, (7) Long Lake, (8) Blue Mountain Lake, (9) Eighth Lake, (10) Seventh Lake, (11) Fourth Lake and (12) Second Lake. Second and Fourth Lakes are parts of essentially one body of water which constitutes the major unit of the Fulton Chain. Raquette Lake (indicated by stippling) lies between Eighth Lake and Blue Mountain Lake.

Needham and Needham (1962); Prescott (1962); Anonymous (1966); and Whitford and Schumacher (1969).

LIGHT PENETRATION

In almost half of the lakes sampled, light penetration exceeded the depth of collection (Table 1). In the lakes where the collection depth exceeded the photic zone, it was within 2 feet in all instances. There were substantial differences in the degree of dystrophy, with Cranberry Lake being the most stained and Blue Mountain Lake the least. In most cases the degree of dystrophy can be explained by reviewing the genesis of the lake and its geography. Cranberry Lake is large and slow-flowing, and its enlargement by damming left all the natural coniferous vegetation in the water. It is fed by slow-moving mature streams which flow through tannic acid-dominated bogs. Blue Mountain Lake is a small, high head-

waters lake. Its water is not as stagnant and bog conditions are not as extensive.

Because of the above-average spring rainfall and the flooding due to Hurricane Agnes (3.75 inches of precipitation on June 21-23, 1972), the light penetration data presented here are probably not typical. As a result of the flooding and subsequent runoff, the stain was diluted and great quantities of nutrients and phytoplankton were probably flushed out of the lakes. It is doubtful that the lakes could have maintained their phytoplankton population levels during this runoff period or that these populations could have recovered to their previous levels by the time the collections were made a week after the storm.

TEMPERATURE

Surface water temperature varied from 16.0° to 20.0° C. (Table 1). Normally the stratification tends to be intense in these dystrophic lakes.

Table 1. Data Recorded Pertaining to the Physical Characteristics of the Lakes Studied

Lake	pH	Light penetration (feet)	Temperature (° C.)	Depth (feet)	Elevation* (feet)	Surface (square miles)
Eaton	5–6	15.1	17.5	27	1,721	0.87
Cranberry	5–6	4.6	16.0	8	1,486	10.90
Lower Saranac	5–6	10.3	18.5	20	1,533	3.57
Middle Saranac	5–6	6.5	19.0	13	1,536	2.15
Upper Saranac	5–6	8.5	18.0	12	1,573	7.90
Tupper	5–6	7.5§	20.0	7.5	1,545	9.75
Long	5–6	9.5	17.9	18	1,627	6.39
Blue Mountain	5–6	18.0	18.8	25	1,789	1.97
Eighth	5–6	14.6	19.0	15.5	1,791	0.49
Seventh	5–6	10.3	19.0	15.5	1,786	1.33
Fourth	5–6	11.5	18.0	23	1,707	3.34
Second	5–6	6.8	19.0	8	1,707	0.41

*From Greeson and Robison (1970).
§Bottom.

At the same time these observations were made, an epilimnion of 23 feet and a metalimnion of 12 feet were present in another dystrophic lake (Raquette Lake) in this area (A. H. Cook, personal communication). It is probable that the 12 lakes in this study would generally have had a similar stratification.

Surface water temperatures of lakes in this region were approximately 1.5° C. lower in 1972 than in 1971, based on the senior author's research on Raquette Lake. No data are available in relation to vertical stratification during or after Hurricane Agnes, but it is likely that in the shallow lakes it broke down due to the flooding and high winds. There was some stratification beginning to form a week after the storm.

pH

A pH of 5-6 was found in all the lakes studied (Table 1). Observations on Raquette Lake (Reynolds, unpbl.), a typical dystrophic lake in the region, showed an average daylight pH of 6.6 before Hurricane Agnes. During early July in 1972, Raquette Lake as well as the lakes in this study showed a pH of approximately 5.3. One explanation that can be offered for this phenomenal decrease in pH is the heavy rains and high winds from Hurricane Agnes. These conditions, occurring a week before the collections, caused a great amount of leaching from the acid bogs surrounding the lakes. Dr. A. H. Cook (personal communication) working on Raquette Lake suggests that the rains washed enough sulfur dioxide and nitrogen dioxide out of the atmosphere and into the lakes to lower the pH to 5.6. By late July, Raquette Lake, and probably the other lakes in the region, had returned to their normal pH profiles.

PHYTOPLANKTON

Of the five divisions recorded (Table 2), the Cyanophyta and Chrysophyta were dominant (Figure 2). The lakes showed all the stages of seasonal succession for temperate lakes. Fourth Lake was dominated by *Tabellaria* and *Melosira*. In this case the number of organisms was high, and it can be concluded it was in spring bloom condition. Tupper Lake and Long Lake showed a predominance of *Tabellaria,* but the productivity was significantly lower than that in Fourth Lake indicating that spring bloom had declined, probably due to reduced nutrients. *Dinobryon* is the typical dominant summer organism in Adirondack lakes. It was the single dominant organism in Eaton, Cranberry, Lower Saranac, Middle Saranac, Upper Saranac, Blue Mountain and Second Lakes. The quantity of *Dinobryon* present showed these lakes to be fairly productive. From previous work on Raquette Lake, we would expect more desmids to have been present than were recorded in these lakes. The unusual weather conditions may have altered the flora and possibly caused the low acidity. Eighth Lake and Seventh Lake showed a flora characteristic of more eutrophic conditions than the other lakes, dominated by *Dinobryon* and *Anabaena*. This higher productivity may have been due to natural conditions or the inflow of sewage from nearby campsites and cottages.

The relative distribution of the major components of the flora is shown in Figure 2. The dominance of any group other than the Chrysophyta was due to a lack of *Dinobryon* in the flora. Where *Dinobryon* was present it completely dominated and led us to consider such lakes more productive. The lack of *Dinobryon* in some lakes resulted in very low productivity and allowed other groups to dominate.

Tressler and Bere (1934) studied the phytoplankton of Blue Mountain,

Table 2. Phytoplankton Organisms Recored in the Samples Examined and Their Distribution Among the Lakes Studied*

Organism	Lake											
	Eaton	Cranberry	Lower Saranac	Middle Saranac	Upper Saranac	Tupper	Long	Blue Mountain	Eighth	Seventh	Fourth	Second
CHLOROPHYTA												
Ankistrodesmus spp.	3	..	..	..	..	..	..	..	..	..	..	..
Arthrodesmus sublantus Kutzing	..	..	..	..	1	..	..	..	..	..	..	..
Binuclearia sp.	..	..	..	..	..	1	..	..	..	..	..	..
Bulbochaete spp.	..	..	..	..	1	1	..	..	..	..	..	..
Chlamydomonas spp.	3	..	17	..	..	..	..	..	..	..	..	..
Chlorella sp.	2	..	..	..	..	..	..	..	..	..	..	..
Closterium spp.	..	4	..	..	..	1	..	..	..	..	..	..
Cosmarium punctulatum Brebisson	..	..	..	..	2	..	1	..	4	2	..	1
Crucigenia spp.	1	..	..	..	..	..	..	..	..	..	..	..
Dictyosphaerium ehrenbergianum Nageli	..	..	..	..	2	..	..	..	..	..	..	..
Dictyosphaerium pulchellum Wood	..	..	..	..	..	1	..	..	..	..	..	..
Gloeocystis spp.	1	..	5	7	1	1	1	10	8	..	1	2
Micractinium pusillum Fresenius	..	..	..	..	..	..	4	..	..	..	..	..
Nephrocytium spp.	2	..	..	..	..	..	..	2	..	..	..	..
Oedogonium spp.	..	..	..	..	1	2	1	..	..	..	..	..
Palmodictyon sp.	..	1	..	..	..	..	..	..	..	..	..	..
Quadrigula spp.	..	..	3	..	..	1	..	..	..	..	..	..
Rhizoclonium sp.	..	1	..	..	..	..	..	..	..	..	..	..
Scenedesmus abundans (Kirchner) Chodat	..	..	..	..	..	2	..	..	15	1	3	1
Staurastrum spp.	..	..	..	1	..	..	..	..	..	..	..	1
Tetraedron sp.	..	..	..	..	..	..	..	..	1	..	..	..
Ulothrix spp.	..	3	..	..	..	..	1	..	..	..	..	..
CHRYSOPHYTA												
Asterionella spp.	..	..	18	161	44	10	6	..	..	..	8	16
Characiopsis acuta (A. Braun) Borzi	..	..	..	..	..	..	1	..	..	..	..	..
Chrysosphaerella spp.	..	..	2	..	..	2	3	..	..	..	..	..
Cyclotella spp.	..	..	2	56	160	2	..	5	1	..	16	..
Cymbella spp.	1	4	2	..	..	3	..	..	2	2	..	1
Diatoma elongatum (Lyngb.) Ag.	..	2	1	3	..	..	..	..	..	..	..	..
Diatoma hiemale (Lyngb.) Herib.	..	5	..	..	..	1	..	..	..	1	..	..
Dinobryon divergens Imhof	1,500	1,500	1,500	1,500	1,000	24	14	2,000	17	47	..	2,000
Dinobryon vanhoeffenii (Krieg.) Bachmann	2,500	1,000	1,000	500	500	15	13	2,000	3	21	..	2,000

Eunotia pectinalis (Kutz.) Rabenhorst	..	..	..	..	..	4	1	..	..	..	..	..
Fragilaria spp.	..	..	10	25	27	19	..	..	1	1	..	..
Gomphonema acuminatum Ehrenberg	..	1	..	..	..	..	..	..	..	.	..	..
Gomphonema olivaceum (Lyngb.) Kutz	..	1	..	..	..	..	..	..	..	..	..	..
Gomphonema spp.	1	..	..	5	..	..	..	..	..	..	..	..
Melosira spp.	1	8	8	16	4	15	22	5	2	20	32	25
Navicula spp.	4	35	6	..	8	18	7	..	2	5	2	4
Nitzchia sigmoidea (Ehr.) W. Smith	..	..	..	..	..	1	..	..	..	..	..	..
Pinnularia spp.	..	4	..	..	7	7	..	..	2	3	1	4
Stephanodiscus spp.	..	..	7	..	..	..	..	..	..	..	..	..
Synedra spp.	1	9	2	..	..	8	..	..	1	..	..	2
Synura spp.	..	..	1	..	38	..	..	..	..	..	..	..
Tabellaria fenestrata (Lyngb.) Kutzing	1	18	9	31	37	123	12	4	12	14	41	8
Tabellaria flocculosa (Roth) Kutzing	..	19	..	..	..	11	3	..	2	1	..	..
CYANOPHYTA												
Anabaena spp.	1	..	6	20	1	44	10	..	22	256	6	377
Aphanocapsa spp.	..	13	..	..	..	..	..	..	..	..	.	..
Chroococcus prescotti Drouet & Daily	..	..	..	..	..	6	..	..	..	..	..	..
Chroococcus spp.	..	..	..	..	23	..	16	8	7	..	8	..
Coelosphaerium sp.	..	1	..	..	..	..	..	..	..	..	..	..
Gloeocapsa spp.	58	..	3	..	..	..	..	..	..	..	..	..
Heterohormogonium sp.	..	2	..	..	..	..	..	..	..	..	..	..
Lyngbya sp.	..	1	..	..	..	..	..	..	..	..	..	..
Merismopedia spp.	1	..	..	..	..	..	8	1	..	..	..	..
Microcystis spp.	2	2	6	..	..	..	..	..	..	..	..	..
Oscillatoria spp.	..	..	..	..	3	1	..	..	..	..	..	1
Scytonema sp.	..	..	..	..	..	..	..	..	..	..	..	12
Spirulina princeps (West & West) G. S. West	..	..	..	..	..	1	..	..	..	..	..	..
EUGLENOPHYTA												
Colacium sp.	..	..	..	..	..	..	..	..	..	..	..	7
PYRROPHYTA												
Ceratium spp.	3	..	8	5	36	..	..	..	..	1	1	3

* Figures represent number of organisms per 10 slides.

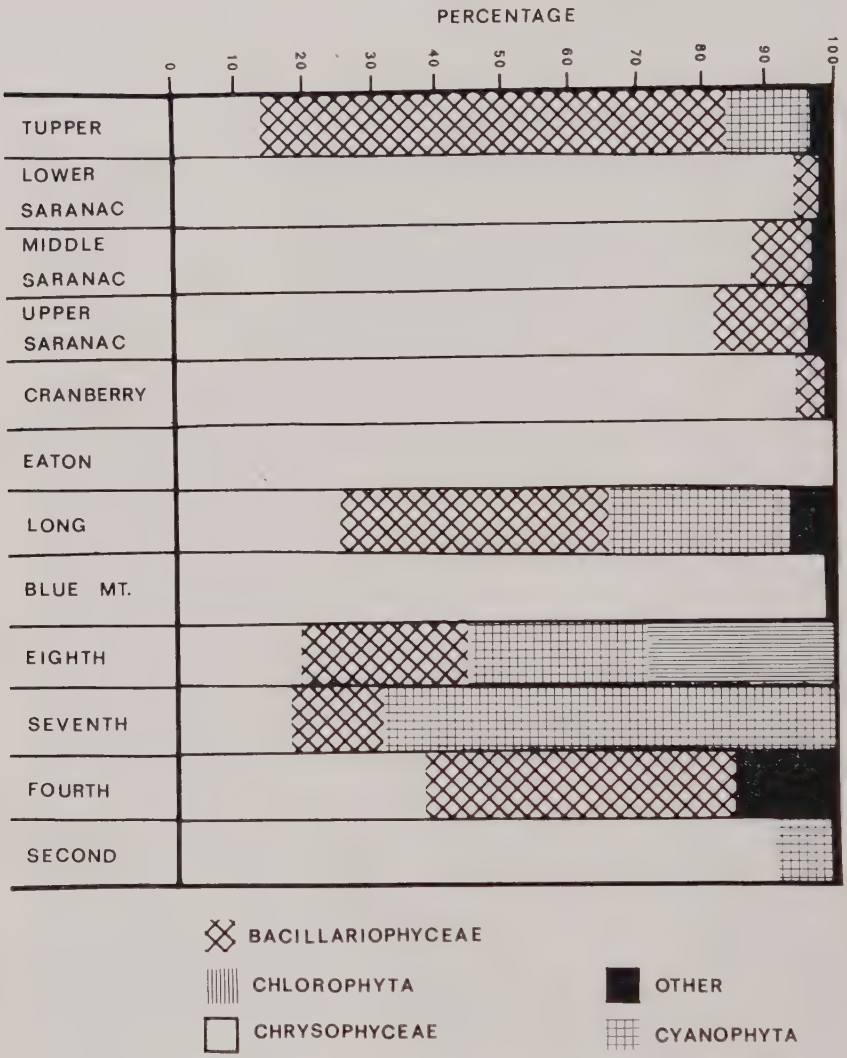

Figure 2. Percentage occurrence of different groups of algae in 12 Adirondack lakes.

Eaton, Tupper and Long Lakes in 1933. This is the only previous phytoplankton work done on any of the lakes covered in the present study. There were some similar findings in spite of the 39-year interval. *Asterionella, Cyclotella* and *Tabellaria* were dominant organisms in these lakes in 1933. *Merismopedia* and *Cosmarium* were rare. Blue Mountain Lake and Eaton Lake were semiproductive in 1972 as in 1933. Tupper Lake supported a large population of *Tabellaria* in both 1933 and 1972.

There were also many differences as might be expected. *Elaktothrix, Botryococcus, Scenedesmus* and *Coelosphaerium* were not important in 1972. *Dinobryon* was not even mentioned in the 1933 report, yet it was the most significant organism in 1972. These changes are explained by eutrophication, Hurricane Agnes and normal annual variation in phytoplankton populations. In Raquette Lake the dominant organism was different during the summers of 1970, 1971 and 1972, and many of subdominants also changed.

These 12 lakes as a whole can be classified as oligotrophic-chrysophycean. Such waters are characteristically dominated by *Dinobryon, Tabellaria* and *Asterionella* with some *Melosira* according to Jarnefelt (1956), Rawson (1956) and Hutchinson (1967). Although some authors consider *Anabaena* and *Melosira* to be eutrophic indicators, they were not numerous enough to be significant in this study. The various dystrophic conditions in the lakes had no noticeable effect on species diversity or distribution.

When Nygaard's (1949) myxophycean, chlorophycean, diatom and compound indexes were applied to each lake, all were indicted to be eutrophic. However, these lakes bear a remarkable resemblance to Store Gribs, a brown-water oligotrophic lake in Denmark described by Nygaard (1955). Low calcium concentrations, restricting the desmids and, therefore, reducing the denominators of the indexes to extremely small numbers or zero, explain why these indexes did not correspond with those for most other brown-water oligotrophic lakes.

It is hoped that this work may lead to more intensive algal and limnological study of this region. Continued observations on an annual or seasonal basis would be necessary to ascribe certain factors to the results recorded. With more accurate field measurements of pH, light and nutrients, plus supplemental laboratory studies with these factors and the dominant organisms, some understanding of the floral differences should be possible.

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COMPARISON OF RINEY AND TOTAL KIDNEY FAT TECHNIQUES FOR EVALUATING THE PHYSICAL CONDITION OF WHITE-TAILED DEER[1]

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ABSTRACT

Two methods for determining kidney fat levels (the Riney technique and total perirenal fat) were compared for 257 white-tailed deer from New York. It was concluded that the most applicable index is one based on total perirenal fat.

The generally accepted technique for determining kidney fat levels was described by Riney (1955) for red deer in New Zealand. Ransom (1965) used it in conjunction with femur marrow fat to evaluate the condition of white-tailed deer in Manitoba. Flux (1971) found it suitable for estimating the condition of hares in New Zealand. Anderson et al. (1972) found this index quite variable for mule deer in Colorado, as did Hessleton and Sauer (1973) for white-tailed deer in New York. Bamford (1970) found the limits of perirenal fat difficult to discern in brush-tailed possum in New Zealand. Blood and Lovaas (1966) used the technique in a weights and measurements study of elk in Manitoba.

Because of the apparent variability of the Riney index, an index based on total perirenal fat was considered. The Riney technique involves standardization of fat measurements by cutting perpendicular to the long axis of the kidney at either end before measuring (Figure 1). For the total kidney fat index, an attempt is made to include all perirenal fat. To compare the two techniques, perirenal fat was measured by both methods for 257 white-tailed deer killed or found dead in New York between August 1972 and January 1973. For each specimen, weight data for both kidneys were averaged. Inconsistency was minimized by having the same person remove the fat from all specimens. Indices, expressed as percentage of the kidney weight, were calculated by the formula

$$\text{kidney fat index} = \frac{\text{perirenal fat}}{\text{kidney weight}} \times 100$$

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[1]A contribution of Federal Aid in Fish and Wildlife Restoration Project W-35-R.

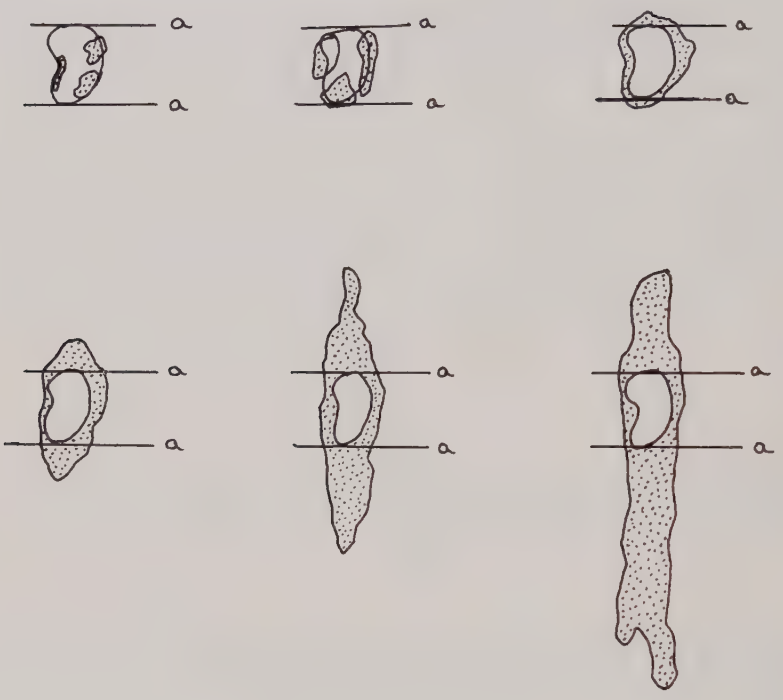

Figure 1. Diagramatic representation of amount of total perirenal fat in relation to amount measured by Riney technique as fat deposition (indicated by stippling) increases. Cutting lines for Riney standardization indicated by "a".

Table 1. Comparison of Mean Kidney Fat Indices, According to Riney Technique and Total Perirenal Fat, for White-tailed Deer From New York

Age (years)	Number	Mean KFI-R		Mean KFI-T	
		Value	Standard error	Value	Standard error
		Male			
½	49	75.58	4.63	235.47	21.25
1½	46	75.77	6.20	260.75	23.38
2½	14	65.75	6.35	247.39	28.12
3½	5	84.52	11.15	252.18	51.83
4½	5	73.38	20.40	266.40	145.78
5½+	3	71.27	31.18	173.83	106.14
		Female			
½	41	80.26	5.47	236.94	20.04
1½	35	157.79	11.90	616.25	49.33
2½	31	145.26	7.35	508.50	35.81
3½	8	121.29	7.21	388.26	68.06
4½	9	91.33	9.21	393.00	61.06
5½+	11	127.84	8.85	414.19	41.19

The indices for the two techniques were designated KFI-R and KFI-T, respectively.

Variation between the two indices was not great when fat levels were extremely low. However, when large amounts of perirenal are present, the increase in fat-pad dimensions is more in longitude than in diameter (Figure 1). As expected, there were much greater differences between the two indices at these higher fat levels.

Table 1 compares the mean values and standard errors for each index according to sex and age for the specimens examined. The differences are significant at the 95 per cent confidence level except for males 4½ and 5½+ years of age. These two samples were very small with large variances.

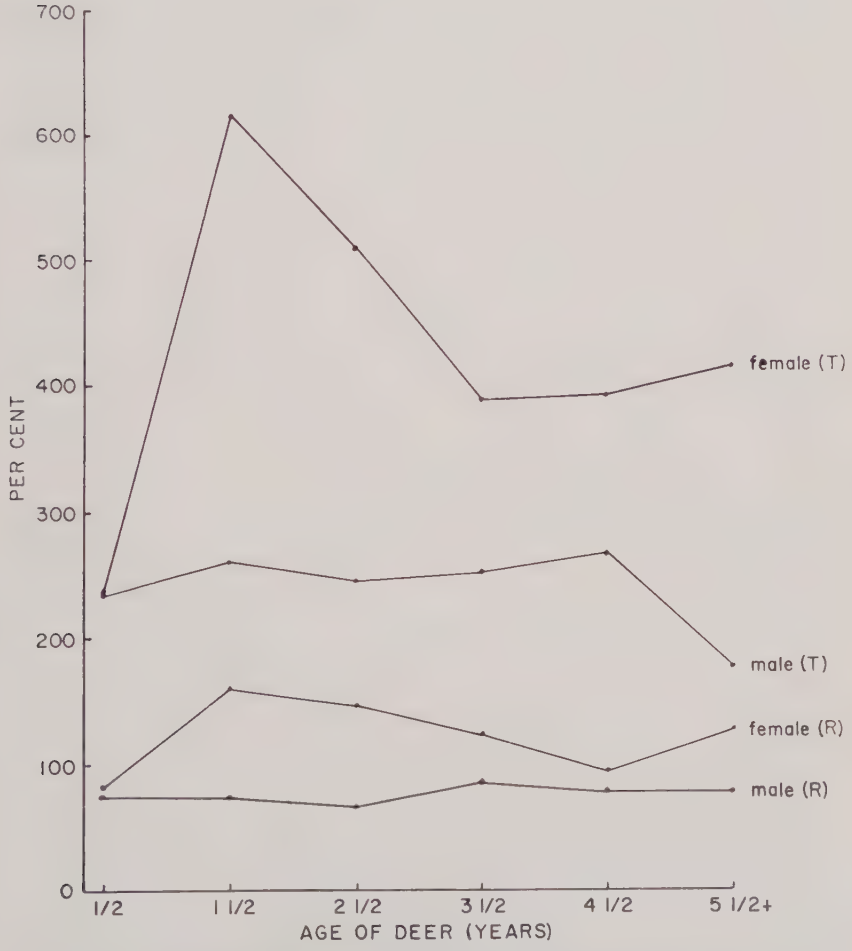

Figure 2. Comparison of kidney fat indices by Riney (R) and total fat (T) techniques, based on kidney weight, for 257 white-tailed deer from New York.

The linear correlation between the two indices was positive and highly significant for fawns ($r=9.354$) and yearlings ($r=9.481$), but it was not significant for adult deer ($r=0.1187$). As Riney index values approach a maximum, it becomes impossible to predict total fat values. Figure 2 shows graphically the differences between the two indices. The range of the index by the Riney method is more limited, and KFI-R would seem, therefore, to be less sensitive to changes in fat buildup than KFI-T. As KFI-R increases, KFI-T increases with expanded amplitude. Thus, KFI-T would also be expected to show more individual variation. Either index may be an indicator of condition in an animal, but it appears that the total fat technique may be more applicable to adult animals with large perirenal fat deposits.

No information is available as to when fat in white-tailed deer reaches a level of pathological obesity. In this study, the deer with the highest kidney fat indices were animals from the semi-confined herd on the Seneca Army Depot near Romulus (N.Y.). This herd has been studied and managed since 1954 (Hesselton et al., 1965). At the time of the present collections, the deer were in excellent condition as indicated by

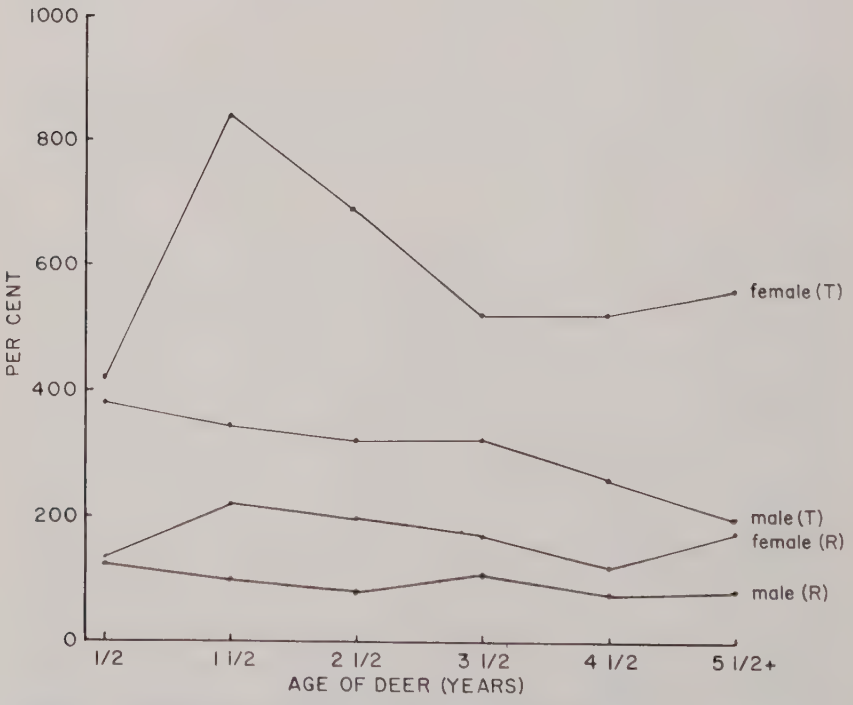

Figure 3. Comparison of kidney fat indices by Riney (R) and total fat (T) techniques, based on dressed weight of animal, for 257 white-tailed deer from New York.

reproductive rates, dressed weights and antler size (Hesselton, 1973). The highest values for KFI-T found in this study (around 1,300 per cent) are, therefore, assumed to be well below the threshold of pathological obesity.

It is apparent that kidney fat levels reflect more than existing range condition. In the present study, indices were highest for 1½-year-old females and decreased somewhat for older females. The majority of these specimens were collected in January. Without the physiological drain of lactation the previous summer, most of this age group may have been able to begin fat deposition earlier than their lactating counterparts.

Hesselton and Sauer (1973) felt that the kidney fat index was not completely satisfactory as an indicator of range condition because transient circumstances, such as a good or poor mast crop, could be reflected in kidney fat levels. While this problem precludes any quantitative use of the index for year-round range evaluation, it does not detract from its usability for evaluating the condition of the deer themselves. Because of its great individual variation in deer from the same range, it is not advisable to use the index (either KFI-R or KFI-T) in a strictly quantitative manner. In addition to range, one must take into account the sex and age of the deer and the time of year of collection.

Riney (1955) included kidney weight in deriving his index in order to permit comparing values for animals of different body size. Hesselton and Sauer (1973) found kidney weight to be quite variable. To investigate the validity of including kidney weight as an adjustment for body size, kidney fat indices based on the dressed weight of the animal were calculated for the deer in the present study, using the following formula.

$$\text{kidney fat index} = \frac{\text{perirenal fat weight (grams)}}{\text{dressed weight (kilograms)}} \times 100$$

These values are shown in Figure 3. Comparison of Figures 2 and 3 reveals virtually identical patterns. It appears then that kidney weight is a valid adjustment for body weight.

We believe that the level of kidney fat is a useful measure of the condition of white-tailed deer and that the most applicable kidney fat index is one based on total perirenal fat.

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AMERICAN LOBSTERS AT ARTIFICIAL REEFS IN NEW YORK [1]

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ABSTRACT

The American lobster *(Homarus americanus)* was studied at two artificial reefs, one in Great South Bay and the other in the Atlantic Ocean. Different catch rates, sizes and sex ratios were observed at these reefs. The differences in population parameters appeared to be primarily a result of onshore migration of adult lobsters from offshore stocks to the oceanic reef. Higher catch rates at the oceanic reef were attributed to both longer fishing time for the gear there and the onshore migration of lobsters from offshore stocks.

Artificial reefs have been constructed experimentally to attract American lobsters (*Homarus americanus*) in Maine (Anonymous, 1972), Massachusetts (Edward Gilfillan, personal communication) and Canada (Scarratt, 1968), but little has been published concerning lobsters (beyond noting their presence) on artificial reefs built for other purposes (Unger, 1966). This paper deals with some characteristics of the lobster populations at two artificial reefs constructed by the Department of Environmental Conservation to attract finfish for anglers.

Figure 1. Map showing the locations of Kismet and Fire Island artificial reefs.

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[1] Contribution No. 74–1 of the Division of Marine and Coastal Resources. The authors gratefully thank Dr. Richard A. Cooper of the Biological Laboratory of the National Marine Fisheries Service at West Boothbay Harbor, Maine, for his assistance and critical review of the manuscript.

Figure 2. Lobster in burrow in rock and building rubble at Fire Island reef.

Kismet reef is located in approximately 6 meters of water in Great South Bay near the Fire Island lighthouse (Figure 1). It is approximately 457 meters long and 46 meters wide. There was no commercial lobster fishery at this reef.

Fire Island reef is located in approximately 21 meters of water in the Atlantic Ocean about 4 kilometers south of the Fire Island lighthouse. It is 1.6 kilometers long and 0.2 kilometer wide. This reef was heavily fished by commercial lobstermen from mid-May through early July. Figure 2 shows a lobster sheltered among the reef materials.

GEAR AND METHODS

Lobsters were caught in rectangular pots fished in two strings of five pots each at each reef without bait or attractors from May through November in 1969 and 1970 and from May through July in 1971. The pots were hauled 74 times at Fire Island reef and 129 times at Kismet reef. Actual fishing time for the pots between hauls varied from 2 to 10 days at Fire Island and from 2 to 4 days at Kismet reef. Bottom water temperatures were recorded each time the pots were hauled.

Only the numbers of lobsters caught were recorded in 1969 and 1970. However, in 1971, all lobsters captured between May 18 and July 28 were measured to the nearest millimeter in carapace length and sexed. This time period coincided with that of intensive commercial fishing for lobsters at Fire Island reef.

FINDINGS

In 1969 and 1970, a total of 409 lobsters were caught in 61 hauls at Fire Island reef for a catch rate of 0.67 per pot per haul. During the same time, 327 lobsters were caught in 108 hauls at the Kismet reef for a catch rate of 0.30 per pot per haul. The catch rate at Fire Island reef remained much higher than that at Kismet reef in 1971 (Table 1).

Although size measurements were not taken in 1969 and 1970, it appeared that the lobsters caught at Fire Island reef were, in general, larger than those caught at Kismet reef. This was confirmed in 1971 (Table 1 and Figure 3). The minimum size at which lobsters could be legally possessed in New York State was 81 millimeters in carapace length. Only two (3.0 per cent) of the 66 lobsters caught at Kismet reef in 1971 were of this size or larger, compared with 20 (18.9 per cent) of those caught at Fire Island reef.

Sex ratios of lobsters differed between the two reefs (Table 1). The late-spring and early-summer population at Kismet reef was clearly dominated by males, while the sex ratio of those caught at Fire Island reef was essentially equal.

Few egg-bearing female lobsters were caught. All females with visible

TABLE 1. LOBSTER CATCH AT TWO ARTIFICIAL REEFS IN 1971

Item	May	June	July
Kismet reef			
Number of hauls	6	11	4
Lobsters caught			
Male	12	24	4
Female	9	17	0
Total	21	41	4
Number per pot per haul	0.35	0.37	0.10
Size*			
Average	56.7	57.8	45.5
Range	38–94	37–77	37–54
Legal-sized lobsters caught			
Number	2	0	0
Per cent	9..5	0.0	0.0
Fire Island reef			
Number of hauls	3	7	3
Lobsters caught			
Male	11	33	10
Female	6	36	10
Total	17	69	20
Number per pot per haul	0.57	0.99	0.67
Size*			
Average	62.4	64.8	68.7
Range	34–89	39–140	49–130
Legal-sized lobsters caught			
Number	4	12	4
Per cent	23.5	17.2	20.0

*Carapace length in millimeters.

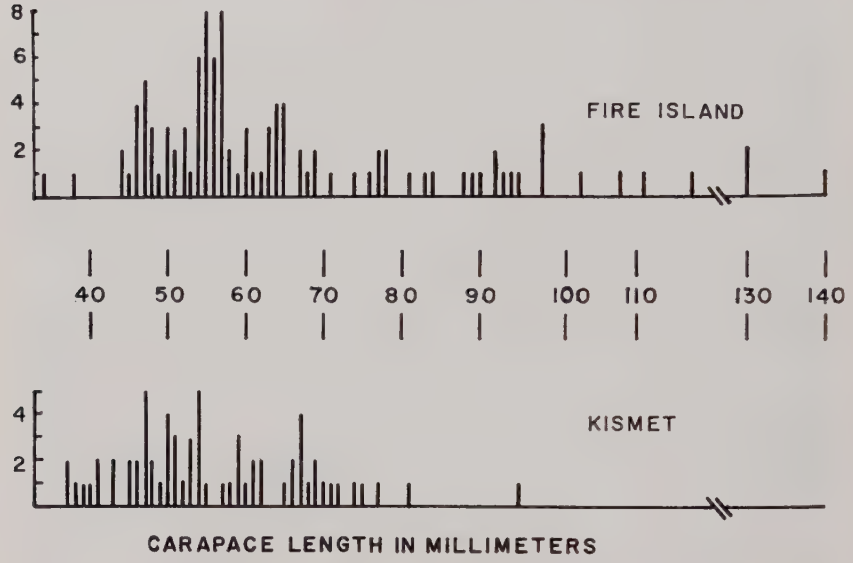

Figure 3. Length-frequency distribution of lobsters caught at Kismet and Fire Island reefs.

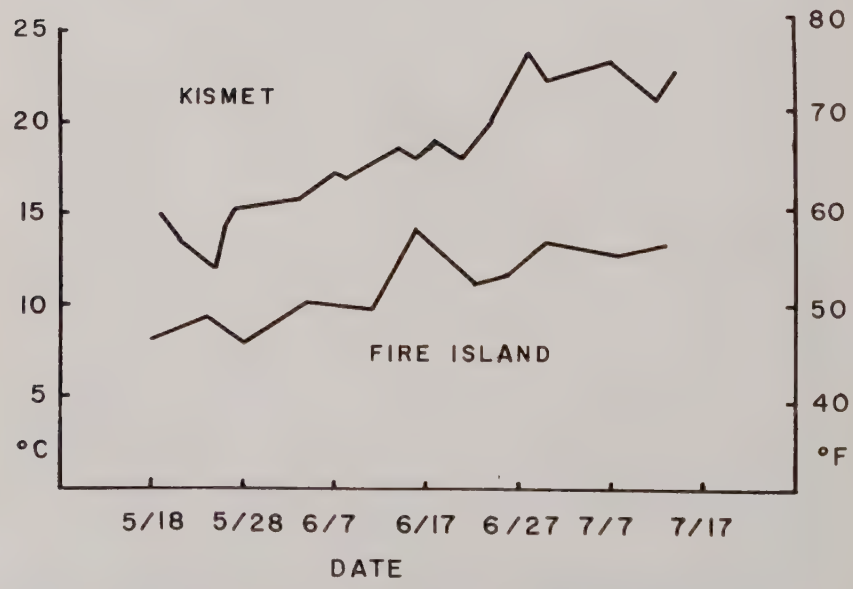

Figure 4. Bottom water temperatures at Kismet and Fire Island reefs in 1971.

eggs that were caught were taken at Fire Island reef in 1969 and 1970.

Bottom water temperatures differed between the two reefs (Figure 4), being always several degrees warmer at Kismet reef in the late spring and early summer than at Fire Island reef.

DISCUSSION AND CONCLUSIONS

At first glance, the differences in bottom water temperature might be suspected as a factor in the differences in population parameters of lobsters caught at the two reefs. However, this may not be so. Cooper and Uzmann (1971) demonstrated that offshore stocks of lobsters contribute to the inshore fisheries for this species in Long Island waters. Cooper is now certain (personal communication) that 90 per cent or more of the lobster catches off the south shore of Long Island are comprised of onshore migrants from the offshore stocks and (based on several hundred tag returns) that these onshore migrants do not enter the bays or inlets. It appears that there is a resident population of mostly juvenile lobsters at Kismet reef. There is probably a similar population at Fire Island reef which is augmented by adult males and females from the offshore stocks. It is most likely that the observed differences in the sex ratios and average sizes of lobsters at the two reefs are a direct result of onshore migration of adults from offshore stocks. The higher catch rates at Fire Island reef may be the result of both longer fishing time for the gear there and onshore migration from offshore lobster stocks.

Most artificial reefs are now built primarily to attract finfish for anglers. However, the presence of legal-sized lobsters and the development of a commercial lobster fishery at Fire Island reef indicates that it may be feasible to build artificial reefs to attract lobsters for commerical fishermen.

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FIELD USE OF 4-AMINOPYRIDINE TO PROTECT CORN FROM BLACKBIRDS IN NEW YORK [1]

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ABSTRACT

The first field use of 4-aminopyridine to prevent blackbird damage to field corn in New York was conducted under the supervision of the U.S. Fish and Wildlife Service in 1972. When the treatment was made at the proper time, damage did not occur in fields that were free of weeds and grass. There was no evidence that any non-target bird species was affected, and mortality among target species was negligible. Live-bird surveys revealed that few non-target birds are found in New York corn fields until the corn has been picked or chopped for silage.

Blackbirds, principally red-winged blackbirds (*Agelaius phoeniceus*) and bronzed grackles (*Quisculus versicolor*), have damaged ripening corn in New York for at least three decades. An average of 68,558 bushels were lost to blackbirds in the State during 1970 (Stone et al., 1972). Damage of this magnitude probably occurs each year (Stone et al., 1973). Many techniques for controlling bird damage have been tried (Mitchell and Linehan, 1967), but a more effective, economical and safe method is needed. This is especially true for the few growers who suffer unusually high losses; such as the 33 bushels per acre loss reported by Caslick (1972).

A toxic, fright-producing chemical, 4-aminopyridine[3], was found to be a highly specific repellent for controlling blackbird damage to corn (De Grazio et al., 1971). This chemical was registered in April 1972 by the U.S. Environmental Protection Agency and may be used in New York State. The label states that the material may only be used "by, or under the supervision of government agencies trained in bird control". The Division of Wildlife Services of the U.S. Fish and Wildlife Service provided this supervision for a blackbird corn-damage-control program during the 1972 damage season. This paper reports the results of the first attempt to protect standing field corn with aerial application of 4-aminopyridine in New York.

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[1] The author wishes to thank John Peterson and Edward Ladd of the U.S. Fish and Wildlife Service for assistance in evaluating the treatments, and Victor Mason and Al Quesnel for making the aerial application.

[2] P.O. Box 150, Albany, N.Y. 12201

[3] Also known as Avitrol. Manufactured by Avitrol Corp., 7644 E. 46th Street, P.O. Box 45141, Tulsa, Oklahoma 74145. Reference to trade names does not imply endorsement of commercial products by the Federal Government or New York State.

METHODS

The treated areas, three on farms in Wayne County and one at the Minor Institute in Clinton County, consisted of 24 fields totalling slightly more than 433 acres (Table 1). Field 2 at the Minor Institute consisted of approximately 12 one-half-acre plots. The area between these plots was fallow, and the actual acreage planted to hybrid corn was not measured. The sequence of events is shown in Table 2.

TABLE 1. NUMBER AND SIZE OF FIELDS TREATED WITH 4-AMINOPYRIDINE ON FOUR FARMS IN NEW YORK IN 1972

Farm	Fields	
	Number	Size (acres)
Wayne County		
Leppert	1	13
	2	18
	3	20
	4	50
Dickens	1	32
	2	40
	3	12
	4	8
	5	4
	6	6
Bartleson	1	15
	2	18
	3	15
	4	10
	5	12
	6	2
	7	20
Clinton County		
Minor Institute	1	5
	2	plots
	3	18
	4	45
	5	35
	6	5
	7	30
Total	24	433+

TABLE 2. SEQUENCE OF EVENTS DURING APPLICATION OF 4-AMINOPYRIDINE IN NEW YORK IN 1972

Date	Event
August 28	First treatment in Wayne County
August 30	First treatment in Clinton County
September 5	Second treatment in Wayne County Evaluation and mortality surveys on Leppert farm
September 6	Second treatment in Clinton County Evaluation and mortality surveys on Bartleson and Dickens farms
September 7–8	Evaluation and mortality surveys in Clinton County

Aerial applications of cracked-corn bait treated with 4-aminopyridine were made by Victor Mason in Wayne County and by Al Quesnel in Clinton County. Aircraft were calibrated to dispense 3 pounds of bait per acre. The bait was applied to only one third of the total acreage in each field, and no bait was applied within 50 feet of a field edge. Three applications were made at 7-day intervals.

Evaluations of bird damage to corn were made before and after treatment. In each of 14 fields, three samples each comprised of 100 consecutive ears were tallied as either damaged or undamaged. These figures were then averaged for each field.

Bird mortality surveys were conducted by pacing off (in chains) randomly selected corn rows and later converting these figures to feet. The number of chains paced were recorded with a tally register. All dead or reacting birds were recorded by species.

In an effort to determine what numbers and species of non-target birds may be exposed to 4-aminopyridine during such treatments, a live-bird survey was conducted on these and a few other areas. All live birds observed in and near 27 fields were recorded. These surveys were conducted on September 5 and 6 in Wayne County, on September 7 in Clinton County and on September 9 and 11 in Ulster County. Supplemental observations were made on September 26 in Addison County, Vermont.

RESULTS AND DISCUSSION

The results of the evaluation of bird damage to corn are presented in

Table 3. Degree of Pre- and Post-season Bird Damage in 14 Fields Treated With 4-aminopyridine in 1972

Farm	Acres	Damage observed		Elapsed time after first treatment (days)
		Before treatment (per cent)	After treatment (per cent)	
Leppert	50	0	trace	8
	20	0	0	8
	18	0	0	8
Dickens	40	36	35	9
	32	31	40	9
	12	39	60	9
Bartleson	15	0	0	9
	20	36	41	9
	2	0	0	9
	12	11	10	9
Minor Institute	45	trace	trace	8
	5	0	0	8
	35	0	1	8
	30	0	0	8
Total	221	xxx	xxx	xxx

Table 3. The degree of damage control achieved at the Leppert farm and Minor Institute was judged excellent. In both instances the fields were weed-free and the timing of the application was perfect. At Minor Institute over the previous five years, damage had averaged 10 per cent with a maximum of 37 per cent (records of the U.S. Fish and Wildlife Service, Albany, N.Y.). In 1972, the first application of 4-aminopyridine on August 30 coincided with the arrival of the first large flocks of red-winged blackbirds, and corn damage was averted. In one 20-acre field at the Bartleson farm damage had already begun (36 per cent), the corn was beginning to dent and the first application was judged to have been about 1 week late. Nevertheless, total damage appeared to be contained at that level. The application did not control damage in a 12-acre field at the Dickens farm because the bait fell into tall grass (Figure 1) where it was not available to the birds.

Figure 1. Blackbird damage to corn resulting from poor weed control which made the bait unavailable to the target species.

A bird mortality survey (Table 4) was conducted in 12 fields totalling 246 acres. Six dead and two reacting blackbirds were found along 10 miles of corn rows. This mortality was less than expected, and it was lower than that reported by either De Grazio et al. (1971) of 581 target birds in 48 fields or Coon (1971) of 139 target birds in 206 treated fields.

Table 4. Number of Birds Found Dead or Reacting on Bird-mortality Survey Covering 10 Miles of 4-aminopyridine-treated Corn Rows in 12 Fields

Farm	Field (acres)	Corn rows walked (feet)	Number of birds	
			Dead	Reacting
Leppert	50	7,722	..	..
	20	2,574	..	1 (red-wing)
Dickens	12	2,046	..	..
	40	4,356	..	..
Bartleson	20	6,402	1 (starling)	..
	2	858	..	..
	12	2,706	..	1 (grackle)
	5	1,122	..	..
Minor Institute	4	11,672	2 (red-wing)	..
	45	9,240	2 (red-wing)	..
	35	2,970	..	..
	plots	528	1 (red-wing)	..
Total	246+	52,196	6	2

Table 5. Birds Observed in Corn Fields and Vicinity

Species	Part of Field*		
	Edge	50-foot margin	Center (treated area)
Target species			
Starling *(Sturnus vulgaris)*	..	..	8
Cowbird *(Molothrus ater)*	..	..	22
Bronzed grackle *(Quiscalus versicolor)*	106	56	151
Red-winged blackbird *(Agelaius phoeniceus)*	..	175	501
Non-target species			
Ring-necked pheasant *(Phasianus colchicus)*	..	..	1
Tree swallow *(Iridoprocne bicolor)*	..	..	350
Ring-billed gull *(Larus delawarensis)*	..	..	13§
Sparrow (unidentified)†	6	11	1
English sparrow *(Passer domesticus)*	3	..	57
Goldfinch *(Spinus tristis)*	16	12	..
Mourning dove *(Zenaidura macroura)*	8	1	..
Blue jay *(Cyanocitta cristata)*	1	4	..
Flicker *(Colaptes auratus)*	1	3	..
Robin *(Turdus migratorius)*	2	1	..
Song sparrow *(Melospiza melodia)*	4	5	..
Killdeer *(Charadrius vociferus)*	3	..	..
Cedar waxwing *(Bombycilla cedorum)*	5	..	..
Chipping sparrow *(Spizella passerina)*	1	..	..

* "Edge" = area from edge to 20 feet away from field; "50-foot margin" = area from edge to 50 feet into field; "center" = the field itself, within 50-foot margin.

§ All the ring-billed gulls were observed in fields in which the corn had been chopped for silage.

† Believed to have been English sparrows, but not positively identified.

It is important to note that no non-target birds were found in the present study.

The live-bird survey was conducted to determine the non-target bird species which may be affected by 4-aminopyridine. The observations are summarized in Table 5. Four non-target species were observed in the treated portion of these fields. Most of the six species observed in the "50-foot margin" were flying over and not perched or feeding. With the exception of the English sparrow, none of these seems likely to be affected by 4-aminopyridine. The ring-billed gulls appeared to use the fields only after the corn had been chopped for silage. At this time the chemical was no longer available. The 350 tree swallows were perched on corn tassels and were feeding on large numbers of aphids (Hemiptera). Because this species is neither a seed eater nor a ground feeder, it is unlikely that it would ingest the treated bait.

One pheasant was observed in the treated area. However, it would be extremely unlikely for a pheasant to ingest a lethal dose of the 0.3 per cent bait diluted with nine parts of clean grain. Besser (1968), in feeding cracked corn treated with 3 per cent 4-aminopyridine to pheasants averaging 1,200 grams, found an LD_{50} of 10 milligrams per kilogram. In the study by De Grazio et al. (1971), which was conducted in some of the best pheasant habitat in North America, no pheasant mortality was observed.

While no mourning doves were observed in the treated areas during the study, numerous doves were seen during October in harvested corn fields in Rensselaer, Jefferson and Wayne Counties. It appears that, in New York, doves rarely use corn fields prior to harvest.

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GENERAL NOTES

OCCURRENCE OF THE SEAWEED BLENNY, RADIATED SHANNY AND SEASNAIL OFF THE SOUTH SHORE OF LONG ISLAND, NEW YORK[1]

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In 1971 and 1972, three rare fishes were captured by Department personnel in fish pots set at an artificial reef off the south shore of Long Island, New York. This reef is located in the Atlantic Ocean approximately 4 kilometers south of the Fire Island lighthouse in about 21 meters of water.

SEAWEED BLENNY

The seaweed blenny *(Blennius marmoreus)* has not been recorded from New York waters since DeKay (1842) reported finding the species (then known as *B. fucorum*) in 1831 "not far from the coast of New-York". More recently, Bohlke and Chaplin (1968) described its range as extending from New York to Venezuela. But they stated that northern records along the United States coast require verification.

On October 29, 1971, a fish identified as a seaweed blenny was captured off Fire Island. Bottom water temperature at the time was 15.5° C. and salinity was 31.9 ppt. The fish measured 21 millimeters in total length and was mottled olive green and light brown. Fin ray counts were: dorsal XII, 18; anal II, 20; pelvic I, 2; and pectoral, 14. The specimen was preserved in 5 per cent formalin and sent to the United States Museum of Natural History where Dr. Victor G. Springer confirmed, with caution, the identification. He noted (personal communication) that the fish was ". . . best identified as *Blennius marmoreus*?. The problem is that no one knows for certain what *Blennius marmoreus* is."

RADIATED SHANNY

The radiated shanny *(Ulvaria subbifurcata)* generally occurs along the northwestern Atlantic coast from Newfoundland to Cape Cod and is considered rare

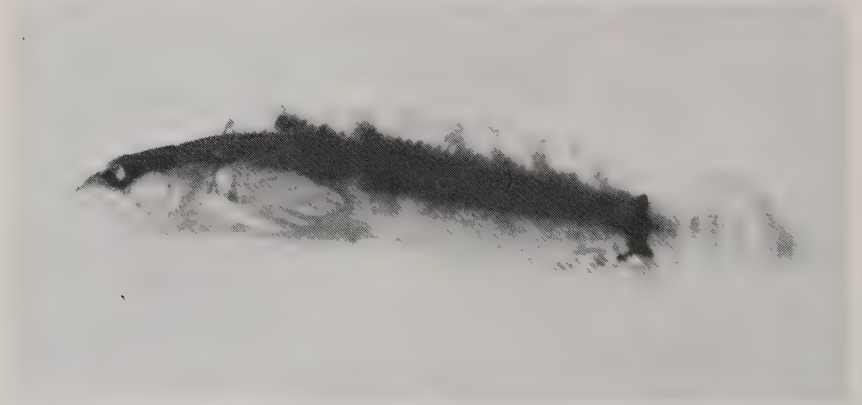

Figure 1. Radiated shanny caught at Fire Island artificial reef on August 16, 1972.

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farther south (Breder, 1948). The only published record of the species from New York waters that the author has found is that of four post-larvae collected in 1938 by Perlmutter (1939) from Gardiner's Bay and Block Island Sound.

On August 16, 1972, a radiated shanny was caught off Fire Island (Figure 1). Bottom water temperature at the time was 17.5° C. and salinity was 31.1 ppt. The fish measured 33 millimeters in total length. This appears to be the first record of this species off the south shore of Long Island and only the fifth from all of New York's marine waters.

SEASNAIL

The seasnail *(Liparis atlanticus)* is usually found along the northwestern Atlantic coast on rocky shores from Newfoundland to Cape Cod, sometimes straggling to the south side of the Cape (Breder, 1948). It was first reported from New York waters only recently, at Hampton Bays in 1967, by Cooley (1968).

Two larval and three juvenile seasnails were collected at Fire Island in 1971 and 1972. The sizes of these fish, dates of capture, and bottom water temperatures and salinities at the time of capture are shown in Table 1. The juvenile caught on November 13, 1972 is shown in Figure 2.

TABLE 1. DATA PERTAINING TO SEASNAILS CAUGHT AT FIRE ISLAND ARTIFICIAL REEF*

Date of capture	Total length	Bottom water temperature	Salinity
June 16, 1971	12	14.0	30.6
	13	14.0	30.6
November 13, 1972	32	11.8	34.6
November 16, 1972	33	10.6	32.6
	36	10.6	32.6

*Total length in millimeters, temperature in degrees Celsius and salinity in parts per thousand.

Figure 2. Seasnail caught at Fire Island artificial reef on November 13, 1972.

The seasnail may not be as rare in New York waters as the literature has indicated. Most fish collections in this area have been made by moving gear, such as seines and trawls, over relatively smooth bottoms. Few collections have been made with stationary gear such as fish pots. The seasnail attaches itself to rocks and other material on rough bottoms, which tends to make it unavailable to most fish-collecting gear. The author suspects there would be more records of the species,

and of other fishes of similar habitats, if stationary collecting gear were used on rocky or rough bottoms.

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POSSIBLE PREDATION OF A GRAY FOX ON A RED FOX PUP[1]

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During April of 1967, in the Town of Milo in Yates County (N.Y.), a gray fox *(Urocyon cinereoargenteus)* vixen was taken in a trap set for taking foxes to control a rabies outbreak. When the vixen was approached, a small live unweaned red fox *(Vulpes fulva)* pup was found which she had apparently put down in order to investigate the lure in the trap set. The vixen was killed and found to be carrying five unborn pups of her own.

This incident could indicate a willingness of the gray fox vixen to mother a pup of another species, but the fact that the red fox pup was still alive does not rule out the possibility that it was a potential food item for the gray fox. Red foxes have often been observed to carry live prey, and even to bury such prey in a shallow cache (Allen B. Sargeant, personal communication), and this habit may be shared by the gray fox as well. The fact that the gray fox was carrying five unborn young but was not lactating is further indication that she intended to eat rather than nurse the red fox pup.

[1]A contribution of the New York State Rabies Control Program.

HEARTWORMS AND MICROFILARIAE IN A GRAY FOX[1]

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The heartworm *(Dirofilaria immitis)* has been reported from the red fox *(Vulpes fulva)* in New York (Erickson, 1944), Minnesota (Schlottlauer, 1964), Connecticut (Hirth and Nielsen, 1966) and Michigan (Stuht and Youatt, 1972). Monson et al. (1973) found it on one of 180 gray foxes *(Urocyon cinereoargenteus)* and in two of 551 red foxes in New York. Walton et al. (1963) examined the blood of 48 gray foxes from Fort Stewart, Georgia, and found them negative for infection with this parasite. None of these authors reported finding *D. immitis* microfilariae in fox blood, and Stuht and Youatt (1972) suggested that the red fox may not be a suitable host. However, Monson et al. (1973) found fully-developed microfilariae within female worms recovered from a red fox and reported it appeared likely that the red fox could act as a definitive host for *D. immitis*. The following case seems to be the first record of both adult worms and microfilariae in a fox.

On May 22, 1973, a female gray fox was shot near a house in the Town of Halfmoon in Saratoga County (N.Y.) and submitted to the Wildlife Research Laboratory at Delmar for necropsy. Examination revealed seven adult heartworms (*D. immitis*). One adult female worm was recovered partly in the right ventricle and partly in the pulmonary artery; three other adult females were in the pulmonary artery; one adult female was in the superior vena cava; and two dead worms were found in branches of the pulmonary artery.

Heart blood was placed on a slide and examined under low-power magnification. Numerous live microfilariae were seen. They moved in a jerky, sporadic fashion and made little, if any, forward progress. Blood smears were made from the heart, lungs and skeletal muscle, fixed in absolute methyl alcohol and stained with Giemsa stain. Numerous microfilaria were present in all of the smears but were most common in those taken from the lung. The *D. immitis* adults and microfilaria were identified according to the taxonomy presented by Levine (1968).

This case strongly suggests that the gray fox is a suitable definitive host for *D. immitis* and can act as a source of heartworm infection for dogs and susceptible wild species.

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